Customisation of Web Content for Desktop and Mobile Devices

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Accessing websites from mobile devices has been gaining popularity but may not give the same results and experiences as accessing them from a personal computer. Growth in the use of mobile devices is accelerating and therefore issues with accessing the web from them are becoming increasingly important. To investigate problems users encountered while accessing websites from mobile devices we conducted a series of surveys and conducted a user trial. Results showed that on mobile devices, users get pages with different structure, terminology, content, and location of content than those on the desktops. Each of these differences negatively impact on the user experience for the site.

To address these issues, we present a server-side adaptation approach to prioritising adaptive pages to different devices through a prioritisation system. The prioritisation approach allows users to prioritise page items for different devices. The prioritisation engine reorders, shows, and removes items based on its priority set by users or developers. With this approach, the overall web page's structure (the parent-child relationships) is preserved and the same terminology, content, and similar location of content are delivered to all devices.

To evaluate the prioritisation system, we conducted user trials in a controlled lab-experiment evaluating the usability and user experience of adaptive pages developed for desktops and prioritised for mobile devices. We compared adaptive pages of a mock Facebook to the actual Facebook version. We also conducted a performance test analysing the performance of the prioritisation engine.

Results demonstrate the usefulness of the Prioritisation engine and the adaptive pages. Participants preferred the Prioritised version and their performance and browsing experience on the Prioritised version is better than that on the Facebook mobile version. Results show

that adaptive pages and prioritisation provides a consistent web experience across different devices.

Keywords: Web adaptation, adaptive page, 'One Web', web page, customisation, prioritisation, server-side adaptation, mobile web, mobile devices, web browsing, user studies/trials.

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Chapter 1
Introduction

The use of mobile devices to access the web is becoming more and more prevalent. This thesis looks at a number of issues regarding the user experience of accessing the web via mobile devices. In particular, we investigate the problems caused by having several versions of a website to cater for access from different types of device. In later chapters, we introduce our prioritisation engine which allows a single page to be adapted for different devices according to the users' preferences.

At the time of writing the number of Internet users has surpassed 2.4 billion; 1.5 billion of these users are from developing countries (ITU, 2011). Mobile phone subscriptions have reached 5.9 billion worldwide with over 4.5 billion subscribers from developing countries. As mobile devices and wireless technologies improve, the number of users accessing the Internet from their mobile phones (or mobile devices) is expected to keep increasing. These mobile devices allow users to access websites from anywhere and at any time.

There are 1.2 mobile web users worldwide (ITU, 2011); 623.3 million mobile web users in the Asia Pacific region in 2011 and it has been estimated that the number will double by 2015[1]. India has about 150 million mobile web users and it is expected that by 2013 the number of users accessing the web from their mobile will be greater than those who access the web from their personal computer (PC) (Ohri, 2011). In Vietnam, 50% of the population access the Internet with 40% of those also accessing the web from mobile devices (Cimigo, 2011). A study by Equation Research (Gomez, 2010b) found that 67% of all web users are also using a mobile device to surf the internet.

There have been vast improvements in mobile device technology, especially smartphones, PDAs, and tablets. This suggests that the experience of viewing web pages on these devices has the potential to be similar to the desktop. However there are still issues with users browsing the web on mobile devices (Gomez, 2010b), particularly because most websites are developed and optimised for desktops and because users have different preferences and use different devices for different tasks.

Accessing websites on mobile devices causes issues such as users getting inadequate content and layout, and having an unsatisfactory browsing experience (see Chapter 2). From our

[1] http://www.emarketer.com/blog/index.php/quick-stat-mobile-internet-users-asiapacific-double-2015/

preliminary studies (see Chapter 3), the unsatisfactory browsing was mostly caused by the mobile website being different from the standard site accessed from the personal computer. The differences between mobile and standard sites included:

- Different structure layout
- Different terminology or naming of items
- Different items presented for different versions
- Different location of items

Generally, users expect comparable mobile browsing experience to that on the PC (Compuware, 2011).

1.1 Research Questions

The main purpose of this study is to investigate a suitable approach to provide users with a consistent but tailored web experience across multiple devices.

This leads to the following questions:

- What are prevalent mobile web issues?
- How can we ensure that users get similar web pages and browsing experience while accessing web pages from different devices?
- Can an adaptive page and prioritisation approach tailor web pages adequately for users with different preferences and devices?

Hence, the objectives of this research are to:

- identify problems of mobile web (while accessing websites from mobile devices)
- investigate the issues of prioritising content on different devices
- examine the usefulness of the prioritisation engine and adaptive pages

1.2 Proposed Research

In this thesis we will:

- Investigate some of the problems encountered with the use of mobile devices for web browsing. In particular, we will investigate types of websites mostly accessed from PC and mobile devices, problems encountered while accessing the websites from mobile

devices; tasks performed in mobile browsing and issues encountered. We will look at users' requirements/expectation of mobile web.

- Describe the development of a prototype of a server-side prioritisation engine that uses a prioritisation and customisation to tailor *adaptive* web pages to different devices based on a user preference profile.
- Provide the results of an empirical evaluation, investigating the effect of '*Adaptive page'* prioritisation approach to users' web experience and performance in terms of completion time, and users' satisfaction and perception of prioritisation for mobile web browsing.

1.3 Thesis Structure

The overall structure of the study takes the form of nine chapters, including this introductory chapter.

Chapter 2 presents a review of the web and mobile device technologies that could affect mobile web. We review current methods of delivering or tailoring website to mobile devices, particularly adaptation approaches and techniques.

Chapter 3 discusses our preliminary studies conducted to identify problems and gather requirements to meet our main research questions. We conducted two surveys and a small-scale user trial. In the first survey we identified the types of websites people accessed most from their personal computer (PC) and mobile devices; and problems users encountered while accessing websites from their mobile device.

Chapter 4 presents our proposed approach and the design of a prioritisation engine to prioritise '*adaptive'* pages for different devices based on users' preferences.

Chapter 5 details how we designed a base 'adaptive page' and implemented the prioritisation engine.

Chapter 6 presents the user evaluation including the research methodology, describing the user trial design, procedures, participants, data collection, and data analysis.

Chapter 7 provides the findings of our trials undertaken to investigate the usefulness of the prioritisation engine and prioritised pages.

Chapter 8 details an evaluation conducted to investigate the performance of the prioritisation engine.

Chapter 9 discusses our findings, propose improvements, research contributions, avenue for future work, and a conclusion for the thesis.

Figure 1.1 illustrates the structure of this thesis.

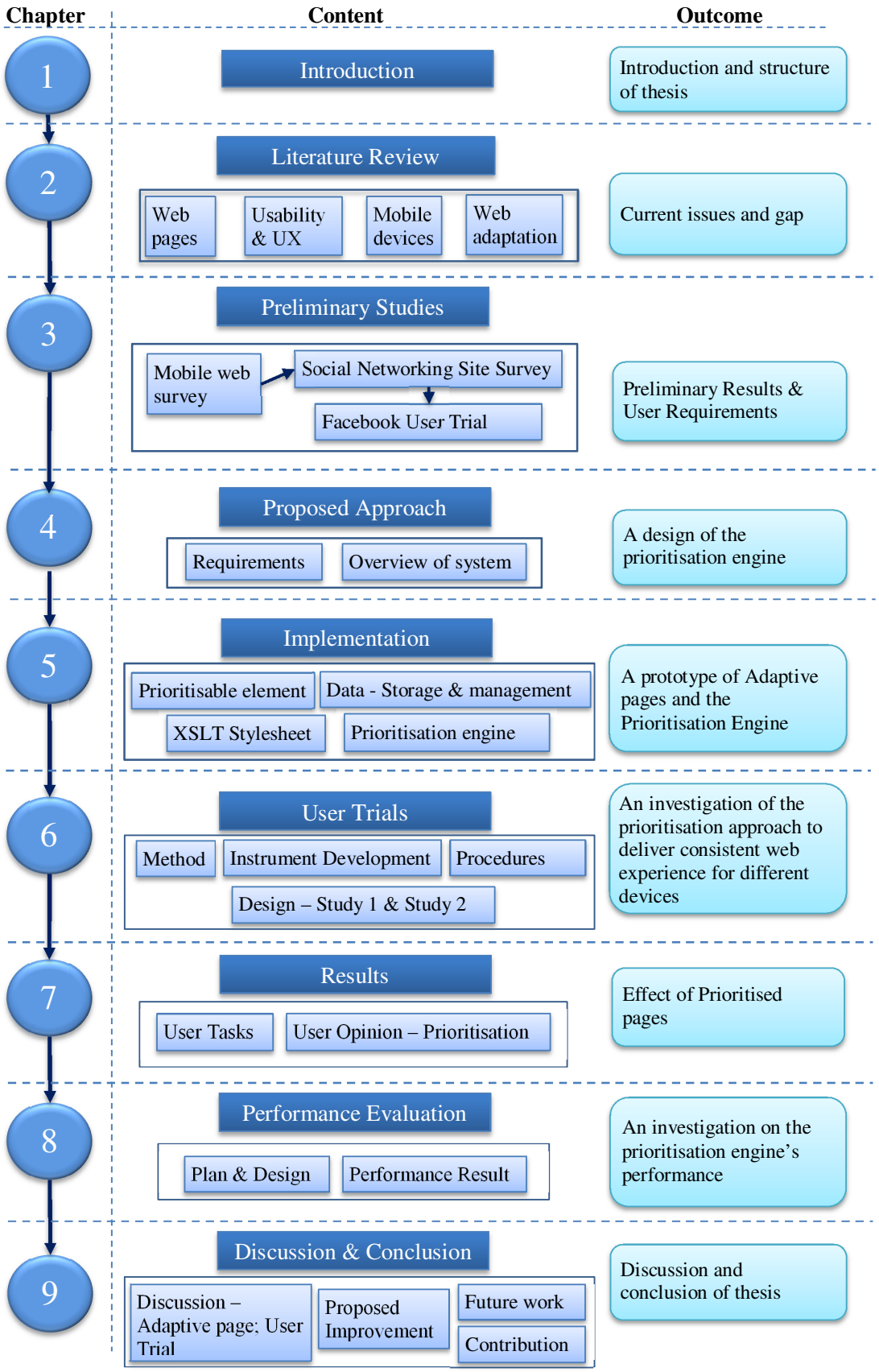


Figure 1.1 Thesis structure

Chapter 2
Literature Review

Developments in web and device technologies have meant that accessing the web on mobile devices is becoming common. However, there are still problems with accessing the web via mobile devices. This chapter discusses mobile websites; the problems that exist with accessing the web via a mobile device; and reviews possible solutions to displaying web pages on mobile devices.

We outline an overview of the web in Section 2.1. Then, we outline the usability and user experience (Section 2.2); mobile device technologies (Section 2.3); and Web on mobile devices (Section 2.4). Next, we discuss the related work on web page adaptation (Section 2.5). Lastly, Section 2.6 summarises this chapter.

2.1 Overview of the Web

This section discusses the types of website and, mobile web and it issues.

2.1.1 Types of Websites

A website is "a set of [web pages] published by the same person, group or institution referring to a common topic" (Kriegel & Schubert, 2004). Websites have become important information sources and communication channels to disseminate and share information. Those accessing the web have different goals and perform various tasks and activities such as information seeking, communication, undertaking transactions (Cui & Roto, 2008; Kellar et al., 2006; Sellen et al., 2002) and browsing (Kellar et al., 2006; Sellen et al., 2002).

There are various types of websites and they can be categorised based on their purpose or function (Tarafdar & Zhang, 2005a, 2005b; Turk, 2001), and goal (Belanger et al., 2006). Qi and Davison (2009) classify web page into subject classification, functional classification, sentiment classification, and other types of classification. Different sites could have similar functions but different goals (Belanger et al., 2006).

Tarafdar and Zhang (2005a, 2005b) classify five categories of websites – portals and search engines; news and information; entertainment; retail; and financial services. Turk (2001) classifies website into communication, information, entertainment, services, and electronic

commerce. Hong and Kim (2004) identify 16 categories of websites based on a Korean government agency consensus. Kane et al. (2009) identify 12 categories of websites commonly viewed on personal computers (PC) and mobile devices.

Based on these classifications, types of websites include educational, business transaction, entertainment, community, and portal and search engine sites. These websites can be accessed from various devices - PCs and mobile devices such as personal digital assistant (PDA) and mobile phones.

Generally, today's popular websites as reported by Alexa.com[2] are Google (search engine), Facebook (social networking site), YouTube (entertainment), and Yahoo! (portal/search engine). Similar websites are also popular for mobile users. A report by Opera (2010) shows that Google, Facebook, YouTube, and Yahoo! were the top mobile sites in 2010.

2.1.2 Mobile web

Mobile web or mobile website refers to the web as accessed from mobile devices. Accessing websites through hand-held devices present some unique problems and challenges (Murugesan & Venkatakrishnan, 2005) and is hindered because, commonly, the web content was designed for desktop computers (Cserkúti et al., 2006). As many websites are initially developed for desktops, users may encounter problems while accessing them from mobile devices. Kane et al. (2009) report inadequate page layout, small screen size of devices, poor network connections, and difficulty entering text as difficulties users encountered during web browsing on their mobile devices. Similarly, studies by Gomez (Compuware, 2011; Gomez, 2010b) report formatting (difficult to read and use); speed (slow download); and that the websites did not function as expected; as problems users encountered while accessing websites from mobile phones.

As stated in Chapter 1, the vast improvements in mobile devices technology, especially smartphones, PDAs, and tablets, indicate that the experience of viewing web pages on these devices could be similar to the desktop. However, the limited capabilities of mobile devices still causes issues with users' experience when browsing web on mobile devices (Gomez, 2010b) especially for those websites developed primarily for desktops. The issues are also caused by users having different preferences and using different devices.

[2] http://www.alexa.com/topsites/global (access date: 26th June, 2012)

2.2 Usability and User Experience

As discussed earlier, although mobile web access is gaining popularity and expected to overtake the standard web access on desktops, users are having issues with the usability and user experience of mobile web. These are due to the fact that most of the websites are primarily developed for the desktops in addition to the limited capabilities of mobile devices. To understand factors that affect the usability and user experience, this section looks at the definitions related to usability and user experience.

2.2.1 Usability

There are many definitions of usability, depending on the context of use. ISO 9241-11 defines usability as "the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency, and satisfaction in a specified context of use" (Bevan, 2001). ISO IEC FCD 9126-1 defines usability as "the capability of the software to be understood, learned, used, and liked by the users when used under specified conditions" (Bevan, 1999). In short, usability refers to the ease of use and ease of learning; it is a measure of how user-friendly a system is (Bradshaw & Marshall, 2007; Nielsen, 2003).

Usability is one of the most important characteristics of websites (Tarafdar & Zhang, 2005b). Matera et al. (2006) define web usability as "the ability of web applications to support particular tasks with effectiveness, efficiency, and satisfaction." Their definition is derived from the ISO 9241-11 definition of usability (Bevan, 2001). Web usability is about creating a website that will enable users to find what they are looking for quickly and efficiently[3].

2.2.2 Usability Attributes and Measures

Usability can be measured using sets of criteria or attributes. Dix et al. (2004) suggest learnability, flexibility, and robustness as three principles that support usability, and Nielsen (1993) characterizes usability into learnability, efficiency, memorability, errors, and satisfaction.

There are many attempts to define general criteria for web usability for general or specific types of website (Palmer, 2002; Pearson & Pearson, 2007; Venkatesh et al., 2003). The studies of web usability are usually based on a set of criteria. For instance, Palmer (2002) uses five dimensions – download delay, navigability, content, interactivity, and responsiveness. Venkatesh et al. (2003) in comparing the perception of wired and wireless websites utilise Microsoft Usability Guidelines (Keeker, 1997) to define usability dimensions – ease of use,

[3] http://www.webcredible.co.uk/user-friendly-resources/web-usability/basics.shtml (access date: 30th Jan 2008)

made for the medium, content, emotion, and promotion. They report that ease of use was significantly more important in a wireless context and stress that a successful web presence does not automatically lead to a successful wireless web presence. Pearson and Pearson (2007) find that navigation, download speed, personalisation, ease of use, and accessibility are the criteria that are important in assessing web usability, with ease of use the most important. Tarafdar and Zhang (2005b) use six factors to look at factors that affect usability - information content, ease of navigation, download speed, customisation and personalisation, security, and availability and accessibility.

2.2.3 User Experience

Like usability, there are many definitions of 'user experience'. There is no agreed or standard definition of a user experience (Botha et al., 2010) or mobile user experience.

The Usability Professionals' Association (UPA)[4] defines user experience as "Every aspect of the user's interaction with a product, service, or company that make[s] up the user's perceptions of the whole". Colbert (2005) defines user experience as "users' perceptions of interaction that constitute qualities of use". ISO CD 9241-210 defines user experience as "all aspects of the user's experience when interacting with the product, service, environment or facility" (Bevan, 2008). The World Wide Web Consortium (W3C)[5] defines user experience as "a set of material rendered by a user agent which may be perceived by a user and with which interaction may be possible".

Generally, user experience is about attitude or feeling that users have towards a product, regardless of the context of use. In this thesis, we will use this definition.

2.3 Mobile Device Technology

Blekas et al. (2006) define the term 'mobile device' as "a device specially designed for synchronous and asynchronous communication while the user is on the move". Mobile devices have different features. The different features or capabilities of each mobile device can affect how the page is delivered or rendered on the device in terms of the presentation layout, the content, and the download speed. The constraints of these features can limit the mobile web usability (Kane et al., 2009) and users' browsing experience or perception towards the web accessed on their mobile devices.

[4] http://www.usabilitybok.org/glossary
[5] http://www.w3.org/TR/di-gloss/#def-user-experience

This section will look at the types of mobile devices, and the components that could affect mobile web browsing.

2.3.1 Types of Mobile Devices

Mobile devices include a wide variety of devices such as tablets, PDAs, smart phones, and mobile phones.

In this study, the term mobile devices will refer to mobile phones, Smartphones and PDAs that uses mobile browser (not using the desktop or standard browsers). The summarised features of PDA, smartphone, and mobile phones are shown in Appendix A.1.

2.3.2 Mobile Operating Systems

There are different types of mobile operating system (OS) that will determine the functions and features available on a mobile device such as wireless application protocol (WAP), email, and text messaging.

A summarised description of currently available operating systems for mobile devices and their features and characteristics are described in the Appendix A.2.

2.3.3 Mobile Browsers

Mobile browsers (also referred to as minibrowsers or micro browsers) enable websites to be displayed on mobile devices. Normally, mobile browsers support HTML with newer versions supporting XHTML, advanced Cascading Style Sheets (CSS), and CSS handheld style sheets. Today, there are many mobile browsers available.

There are two types of mobile browsers – default browsers or the browser pre-installed by the mobile phone vendor and user-installable browsers. Different type of mobile browsers could also affect how mobile web is rendered and displayed. A description of current major mobile browsers and their capabilities is summarised in Appendix A.3.

2.3.4 Mobile Network Connections

Accessing websites using mobile devices with different network connections can also give different output in term of speeds of access. Appendix A.4 shows the common network connections for mobile devices.

2.3.5 Mobile Emulator

An emulator is software that uses the same rendering code as an actual physical device. The emulator allows users to simulate how the device will work, although the output may not be exactly the same as the actual devices (Ballard, 2007). For mobile phones, mobile/WAP emulators are available on the web for users or web designers to see how websites would look like on specific types of mobile phone models. Users can select a phone model and key in the URL resource to be viewed on the phone. These emulators are very useful for users to view how a website would look like on a particular make and model of mobile phones. Figure 2.1 shows a few examples of websites on two online emulators[6].

news.bbc.co.uk www.lincoln.ac.nz www.google.co.nz nz.yahoo.com

Figure 2.1 Screenshots of a few websites viewed on mobile phone emulators

The figure shows that while some sites rendered well on the emulator, others such as Lincoln University's website rendered badly. This is because Lincoln University's website does not have a mobile site or apply any mechanism to tailor its website to 'adequately' fit mobile devices. However, the BBC, Google, and Yahoo! website redirect users to their mobile site.

2.4 Web on Mobile Devices

A successful web presence does not automatically lead to a successful wireless web presence (Venkatesh et al., 2003). Techniques to display web pages on mobile devices are important. The techniques can be categorised into two main categories: manual (or device specific authoring) and automatic re-authoring (or adaption) (Artail & Raydan, 2005; Bickmore et al., 1999). These techniques usually minimise the content to be delivered to mobile devices.

[6] http://mtld.mobi/emulator.php (access date: January 2008)

Minimising the content to be delivered to mobile devices is necessary (Venkatakrishnan & Murugesan, 2005) to ensure that they can be rendered and displayed adequately on mobile devices. As mobile devices probably get all the information/content from many web pages, minimising the content will also ensure that pages delivered to mobile devices are not over-crowded, tampering with users' browsing experience.

2.4.1 Alternative Versions of Sites

In manual authoring or device specific authoring, several alternative versions of web pages are developed to suit different types of devices; it normally produces good quality pages but is a difficult approach (Artail & Raydan, 2005). An example of this technique is to have standard site for desktop access and a mobile site for mobile access. This is employed by sites such as Facebook[7], Air New Zealand[8], and Stuff[9]. Having different versions of pages is difficult to maintain and causes inconsistency between versions as admitted by Facebook (Byron, 2011):

> "*Every time we launched a new feature, we had to build it multiple times across different code bases: once for facebook.com, then again for m.facebook.com, touch.facebook.com, and in native applications as well. Honestly, we weren't very good at doing this, so certain features were missing on different devices".*

2.4.2 Automatic Adaptation

Automatic re-authoring or adaptation approach employs a content adaptation method to tailor websites developed for desktops computers to mobile devices (Ahmadi & Kong, 2008; Bickmore et al., 1999; Bila et al., 2007; Xiao et al., 2008). This approach ensures the same web content is delivered to different devices; only one version of a web page needs to be developed and maintained; an adaptation engine or transcoding module converts the pages to tailor them to mobile devices (Bickmore et al., 1999). This approach supports the 'One Web' idea.

'One Web' is an approach to ensuring device independent web pages, where only one version of web pages need to be developed, but they can be viewed or accessed by different devices. Users will access the same web pages (same sources) regardless of devices they are using. According to the W3C (2008), 'One Web' means "making, as far as is reasonable, the same information and services available to users irrespective of the device they are using". The idea

[7] www.facebook.com / m.facebook.com
[8] www.airnewzealand.co.nz / airnz.mobi
[9] www.stuff.co.nz / m.stuff.co.nz

of 'One Web' is to keep content of website available regardless of the device available to users. This means, the website may be presented differently in different devices but users will get the same content. The following section discusses adaptation in more detail.

2.5 Web Adaptation for Mobile Devices

This section reviews the literature concerning the use of adaptation engines to tailor websites to mobile devices.

Many adaptation techniques have been investigated to reduce, customise, and adapt web content for mobile devices (Ahmadi & Kong, 2012; Bickmore et al., 1999; Bila et al., 2007; Caetano et al., 2007; Kulkarni & Klemmer, 2011; Nichols & Lau, 2008; Xiao et al., 2009; Xiao et al., 2008).

According to the W3C, adaptation is "a process of selection, generation or modification that produces one or more perceivable units in response to a requested uniform resource identifier in a given delivery context" (Lewis, 2005). In general, the goal of web adaptation is to tailor web content to be "adequately" delivered to mobile devices. In discussing adaptation, a few terms are commonly related to adaptation:

- **Transcoding**

  Transcoding is the process of converting data from one format to another (Ihde et al., 2001). It involves sets of rules or transcoding heuristics. A few sets of early transcoding heuristics introduced to adapt web pages to mobile phones (Bickmore et al., 1999; Bickmore & Schilit, 1997; Hwang et al., 2003; Whang et al., 2001) were used to minimise the page content. For example, the "first sentence elision transform" by Bickmore et al. is a rule to transform the first sentence of each block of text into hyperlink and hide the rest of the text; and the image reduction and elision transform is the transcoding rule that replaces images with their alt tags.

  In addition to these heuristics, new heuristics with specific constraints can be generated depending on the need.

- **Delivery context**

  Delivery context refers to "[a] set of attributes that characterizes the capabilities of the access mechanism, the preferences of the user and other aspects of the context into which a web page is to be delivered" (W3C, 2006). Delivery context then could include the devices' profile containing the delivery device's capabilities, the delivery network's

characteristics, and users' profile including users' preferences, users' preferred language or their location (Butler et al., 2002).

- **The Composite Capabilities/Preferences Profile**

  The Composite Capabilities/Preferences Profile (CC/PP) is a data format that expresses information about delivery context (W3C, 2004).

- **Document Object Model**

  The Document Object Model (DOM) "is a platform- and language-neutral interface that will allow programs and scripts to dynamically access and update the content, structure and style of documents [i.e. HTML, XHTML, and XML]" (Hégaret et al., 2005).

- **RDF Site Summary / Really Simple Syndication**

  RDF Site Summary or Really Simple Syndication (RSS) is a lightweight XML format/application (Beged-Dov et al., 2000) and a web content syndication format (RSS Advisory Board 2009), which summarizes website.

- **XML Path Language**

  The XML Path Language (XPath) is a language for addressing parts of an XML document, designed to be used by both XSL Transformations (XSLT) and XPointer, providing basic facilities for strings, numbers and Booleans manipulation (W3C, 1999b).

A few commercial adaptation systems, such as Mowser[10], and Skweezer[11], are available to tailor web pages to mobile devices. Each of these commercial adaptation systems or transcoders (transcoding systems) works differently and thus delivers the site differently (in terms of speed and content/layout). Users need to access the transcoder site and specify the URL of the page to be viewed on their mobile devices.

In addition, there have been many research efforts in approach to adapting web pages for mobile devices, which will be further discussed in the following section.

2.5.1 Adaptation Types and Mechanism

Adaptation can be grouped into two main categories (in terms of when the adaptation occurs) – static adaptation that pre-processes and stores multiple versions of content, and dynamic

[10] http://mowser.com/
[11] http://www.skweezer.com/

adaptation that performs the adaptation on-the-fly or in real time (Lei & Georganas, 2001; Yang et al., 2008).

Generally, content adaptation is a method of transforming original content to a version suitable for display on the requesting device (Mohan et al., 1999; Mohomed et al., 2006). Content adaptation occurs when any part of the content is modified from its original source. The mechanism of content adaptation ("what" to be adapted) includes the content's format, size, characteristics, or layout adaptation (Fudzee & Abawajy, 2008). Changes in any of these factors will affect the overall page layout or appearance.

Layout adaptation focuses on the way web page layouts are being restructured to fit the devices' screen. Automatic adaptation approach for layout adaptation is classified into two main categories – page reformatting and page scaling (Lam & Baudisch, 2005). Page reformatting includes the change or alteration in the page format such as transforming the page layout into a single column layout, eliminating images or animation, and splitting page into subpages. Repositioning and resizing HTML elements can be used to adapt the pages layout. For example, the location of elements can be re-arranged using a sorting mechanism; and their width or height can be resized by changing the attributes of the elements using Cascading Style Sheet (CSS). Page scaling reduces the page into smaller version known as a thumbnail; the aim is to preserve the original layout.

2.5.2 Adaptation Approaches

There are three main adaptation approaches (in terms of the place the adaptation occurs): client-side adaptation, intermediate (proxy) adaptation, and server-side adaptation (Butler et al., 2002; Kim et al., 2007). Adaptation could take place in any of those three places. In addition, adaptation could also occur in more than one place, which is referred to as a hybrid or distributed approach.

Client-side Adaptation

In client-side adaptation, adaptation occurs (or is done) on the client device and is mainly controlled by the device's and the browser's capabilities.

Roto et al. (2006) introduce Minimap, a web page visualization method that provides an overview presentation of the entire page on top of the adapted page during scrolling action. This is done to provide users with the overview of the current position of the page. The page scaling adaptation system modifies the CSS of the original page to scale every page elements (text and layout) and fit them to the screen. It also scales down images to fit in the viewport of

the device's browser. This adaptation system works in the specific mobile browsers and is in contrast to the Narrow layout method. The Narrow layout method formatted the content to fit the screen width in a single column, and the order of content displayed follows the order they were initially coded in the original layout (the top content is displayed first). A user study conducted by Roto et al., focusing on viewing and navigating on web pages, showed that Minimap scores better than the Narrow layout method.

Buyukkokten et al. (2000; 2002) introduce a browser for PDAs called Power Browser. Page layout is adapted by generating an outline-like summary view of a web page using heuristics. The summary is extracted from important texts such as anchor text, URL structure, or ALT tags. Users can expand or collapse the links for interaction with each summarised items. While text summarisation simplifies the display of web page, it loses the visual context of the page because styles and images are eliminated.

Ahmadi and Kong (2012) introduce an adaptation approach that looks at content detection and layout adaptation by analysing the original page's DOM structure and visual layout. The adaptation system uses heuristic rules that detects and splits the DOM elements of content-related parts into subpages. The system provides a table of content for the page and navigation links for each subpages. To implement their approach, a Small Screen Device (SSD) Browser prototype has been developed. The browser allows users to remove or preserve the web page formatting, and change the font size. In their user study conducted to compare the usability of the browser with Opera mobile, Ahmadi and Kong reported that the SSD browser was slightly better in the area of subjective satisfaction, efficiency, and aesthetic. The splitting of pages into subpages reduces the need to scroll; however, it introduces additional navigation tasks or clicks.

Baudisch et al. (2004) introduce a browser that presents web pages using a fisheye view named Fishnet. Other examples of client-side adaptation approach are mobile or micro browsers that reside on the client devices. Opera Mobile is a commercial browser that uses Small Screen Rendering (SSR) (OperaSoftware, 2010) technologies to adapt web pages to users' device. It adapts web pages into a single column layout and offers a zooming feature.

Similarly, SmartView (Milic-Frayling & Sommerer, 2002) also adapts the page layout by partitioning a web page into segments, presented in a single column layout. The single column layout eliminates horizontal scrolling but increases vertical scrolling.

Zooming presentation gives users an overview of the page, normally in a smaller scale of the page, that users could select (or zoom in) sections of their interest. For example, touch devices

allow users to tap or pinch on items to enlarge or reduce their display. This pinching or zooming seems appropriate for pages that are already familiar to the users. Frequent switching between overview and the detail view, however, requires users to reorient themselves (Baudisch et al., 2004), which waste time (Baudisch et al., 2002) and may cause users loss of context (Adipat et al., 2011).

Intermediate/Proxy Side Adaptation

In intermediate adaptation, the adaptation engine resides on a proxy server remote from both the web server and the client device. Although this approach could overcome a mobile device's weak processing capabilities, it requires clients to go through a proxy. The proxy may not have direct information about client or page content to adapt the pages appropriately.

Digestor (Bickmore & Schilit, 1997) is an automatic adaptation engine that uses HTTP proxy to automatically re-author web pages for small screen devices. Digestor uses sets of transcoding rules to adapt the page content. For example, a block of text is replaced by its first sentence as a link to the original text block. A section header is used as link to outline the content of the whole sections. This approach is good in reducing the text on a page; however, it splits the page into multiple layers that require more clicks to go back and forth to the main content.

WebAlchemist by Whang et al. (2001) uses a structure-aware presentation method in attempting to preserve the layout of the adapted pages. WebAlchemist follows a new sequence of heuristics such as improved outlining transform and selective outlining transform. In addition to transforming section headers to hyperlink, it also transforms <*ul*> to hyperlink and groups corresponding <*li*> into subpages. In the extended WebAlchemist (Hwang et al., 2003), the web pages are split into subgroups reduced into hyperlinks using summarisation techniques to represent the subgroups.

An adaptation technique proposed by Chen et al. (2003; 2005) detects page' structure and splits the page into subpages using thumbnail representation of a page and index to the subpages. This technique was claimed to be applicable at the client, the proxy, or the server. No user study was discussed. An evaluation on the processing time showed that it took less than 200 milliseconds to perform both page analysis and page splitting and more than 800 milliseconds to generate the thumbnail (Chen et al., 2003).

Lam and Baudisch (2005) present Summary Thumbnails, a proxy based adaptation engine that summarizes the content of full web pages to a thumbnail view with a text summary and

provides links for the details. It reduces text by removing frequent words but retains keywords to keep the text/structure meaningful. This technique is good in that highlights of page content are provided. It presents only part of web pages in summarised text that users can first read before deciding if they want to read the rest of the text. Not only that generating effective summary that accurately represents the main idea is difficult, this approach could also introduce a few more navigation tasks – users need to navigate between the summarised links and the content page.

Xiao et al. (2009) present an adaptation system that transforms web pages into subpages to fit a device's screen width by enhancing the thumbnail technique. The system, SPTransform, employs thumbnail presentation and details transformation that uses textual enhanced thumbnail that adds a summary to the thumbnails. This technique preserves the visual context of the original page. A usability study conducted to test the subjective and objective performance of browsing experience showed that users' browsing experience in terms of task completion time and input effort are better on the SPTransform than on the Opera browser.

Kulkarni and Klemmer (2011) are working on an automatic proxy-side adaptation system that will adapt desktop pages using machine learning and heuristics approach. Page's items or components are identified based on its DOM elements and set into classifiers. Pages with selected components are transformed into a single column layout and items are displayed in the order they were initially coded.

Research by (Blekas et al., 2006; Garofalakis & Stefanis, 2007) uses RSS feeds to adapt content to users' devices. Using RSS, the layout of the original page is not preserved; only links and text are maintained and images and styles are removed.

Server-side Adaptation

In server-side adaptation, the adaptation engine resides on the server; the page developer has more control over how and what to adapt content to mobile devices (Laakko, 2008). The strength of server side adaptation is that it overcomes mobile devices' weak processing capabilities and could result in a better adaptation, particularly if the server knows the device capabilities. Examples of server-side adaptation systems include the work done by (Artail & Raydan, 2005; Chua et al., 2005; Kim & Lee, 2006; Laakko, 2008; Manoharan, 2007).

Artail and Raydan (2005) introduce an adaptation engine that produces a mobile aware web pages based on automatic detection of device type and screen size. It aims to preserve the web page's structure while reducing size of elements, hiding parts of text, and transforming tables

into text. It loads the whole page and uses first sentence elision to hide certain page element from being displayed but keeping them on the page. A usability test conducted showed an overall satisfaction with the performance of the approach – that although the horizontal alignments of many elements were not maintained, the approach was effective in retaining the relationships among table elements and producing over average quality of displayed image.

Kim & Lee (2006) introduce a transcoding system based on CC/PP and annotation. The system splits web pages into smaller pages and provides a navigation map to represent the relations of the split pages. Splitting pages into subpages may introduce more clicks between levels of pages.

A dynamic content management and delivery system (Manoharan, 2007) adapts a few types of "content" to suit the device. It converts content from one format into another.

Comparison of Adaptation Approaches

As discussed earlier, adaptation may be done in any or in all the three locations - the client, proxy, and/or server. Combinations of these approaches may produce a better adaptation/result. Table 2.1 summarises the comparison of the three approaches.

Table 2.1 Comparison of adaptation approaches

	Client	Intermediate/Proxy	Server
Advantages	▪ Always render the final output based on device capabilities ▪ Client could choose to enable/disable functions/ styling	▪ Can retrieve input/source from other servers and proxies ▪ Overcomes device's weak processing capability ▪ Can retrieve the whole site at once – reduce the time to download site from server ▪ Do not require users to download software. ▪	▪ Web page developers have full control and direct information about content ▪ Developers can control the adaptation since the page and adaption is on the same server. ▪ Can have both offline and on-the-fly adaptation ▪ Reduce processing /fetching time ▪ Overcomes client device's limited processing capability ▪ Does not require installation of specific software on devices ▪ Technique should work with any browser.

	Client	Intermediate/Proxy	Server
Disadvantages	▪ Performance issues due to limitation of device's capabilities – limited bandwidth, processing power, - device/browser dependent ▪ Users need to download or install software/browser on devices. – may require updates to new adaptation/ version/ bugs fixed. ▪ Slow download page – devices need to download the original page before adaptation	▪ Less author control – does not have direct information about content – may omit important content ▪ Requires more page processing time – retrieve content from server ▪ Requires request to go through proxy ▪ Need to connect to the proxy and need to know which proxy – configure proxy server setting ▪ Users need to configure browser to use the proxy ▪ May cause bottleneck	▪ May cause bottleneck / traffic ▪ May cause overload - has to manage all computation and processing ▪ May have heavy load to process all adaptation and requests ▪ Use of cache may help ▪ Overhead to the servers.

More studies are now working on intermediate or server side adaptation, or a hybrid of the three approaches. The main concern is the types of adaptation done and how well the adapted page is delivered to the users and whether it meets users' expectations.

The mobile browsers that devices are using may influence the adaptation results. Many browsers reconstruct web pages to fit in the mobile screen.

The study by Cho et al. (2006) looks at distributing and dividing the adaptation process among the client, the proxy, and the server. The aim was to minimise the process on one end and speed up the whole adaptation process. This reduces the adaptation burden or problem of having the workload concentrated only on one 'processor' (i.e. only to the client, the proxy, or the server). The adaptation process would be distributed adequately among the three processors depending on their resource usage. System evaluations were conducted to evaluate system's response time and system's stability, where the number of users was increased through simulation. The evaluations, comparing the standard approach (adaptation done on the server) and the proposed approach showed that the processing speed was faster on the proposed approach, indicating an improvement in response time and system stability.

2.5.3 Customisation and Personalisation

Some adaptation engines also provide customisation or personalisation features. Customisation and personalisation have similar aims – to deliver only a portion of content of

web pages that are of interest to a particular user. Customisation aims to allow users to determine the content of their interest. In contrast, personalisation aims to recommend and provide users with items of their interest without requiring users to specify it (Anand & Mobasher, 2005).

The term customisation and personalisation are sometimes used interchangeably. For example, in explaining their concept (adaptation approach) Kao et al. (2009) use the term personalisation when referring to customisation. Nielsen (2009) defines customisation as "when users determine what they want to have" and personalisation as "when the system determines what to be presented based on prediction or history of users' preferences....". In this study, we will use Nielsen's definitions.

Types of Customisation

Customisation as discussed earlier aims to adapt web pages based on users' preferences. The customisation could occur in different forms. It occurs when users are allow to change or perform some modification to the original look and feels (or the structure) of the web page.

Customisation can occur when users are allowed to determine which parts of a page's content to display and/or how they are to be modified. For instance, users can modify the position of the page's user interface (UI) or content, page's setting or preferences, and the page's skin or font size[12].

- **Reposition the user interfaces (UI) elements and content on the page**

  This is done by moving, adding, and/or removing blocks of content on the page. For example, users can re-arrange (drag and drop) blocks of content on the page. User could also assign priority to sections/blocks of contents/functions that they want to be displayed first. Examples of pages (or websites) include Yahoo! and iGoogle.

- **Modification of setting/preferences**

  In this method, users can determine how many and/or which blocks of content to be displayed on a page. Users can turn on/off images/graphics/audio/video; users can add/remove applications and widgets.

- **Change of skin colours or font sizes**

  Change of skin colours or the font sizes of a page (or websites) is an example of a basic form of customisation.

[12] http://www.webcredible.co.uk/user-friendly-resources/web-usability/customisation.shtml (access date: 22.05.2009)

While customisation on the device is device dependent, customisation on the web server is device independent and is more suitable for 'One Web' approach. We will look at examples of customisation in the next section.

Examples of Adaptation by Customisation

Several studies have investigated approaches to customising web pages, which allow users to determine content or items of their interest, for mobile devices.

Highlight (Nichols & Lau, 2008) allows users to create a mobile version of existing websites on a desktop. Highlight splits website pages into multiple pages or "pagelets", based on tasks that users demonstrate on a desktop version. This helps to reduce individual page size and download time on the mobile devices. Highlight allows users to test their customised applications. If there are missing tasks, users can add them to the application. It is suitable for sites with tasks that are frequently performed by users. For example, a user might create a mobile application for a particular airport consisting of only the list of arrival times and search function for a particular flight. This application is saved in a proxy server. To use the application on the user's mobile device, the user has to go to the proxy server main page and select the application from a list of applications. These were all done through Highlight Designer, a proxy-side adaptation system that adapts the page content and layout. An informal user study conducted with three users showed that Highlight Designer is easy to use even by novice users. An empirical evaluation comparing performing the same set of tasks using Highlight to browse with desktop browser features showed that Highlight application reduces the number of interactions. While this system (a Firefox extension) is good particularly for specific task-oriented websites, it may not be suitable for other types of websites such as informational and community sites. In addition, it requires the use of a specific browser, extra set up time, and requires users to access the proxy site first.

PageTailor (Bila et al., 2007) is a reusable end-user customisation tool for the mobile web, which allows customisation to be made on a user's browser via a plug-in. It is targeted to PDA users and is implemented on Minimo web browser. It allows users to adapt the layout of web pages in which users can move, remove, or resize page items. The customisation is stored on the device's persistent storage, thus allowing the same customisation to be applied on each visit until the cookies expire. PageTailor first loads the whole page (except images, which are loaded after the customisation rules/preferences are applied) on the browser and applies the customisation on the DOM tree. The customisation is done once or for a minimal number of pages and is long lasting. User studies conducted by Bila et al., in lab experiments, showed

that the customisation lasts at least a month and is applicable to more than 75% of pages with similar structure. Other pages with similar page structure will also be customised based on the earlier customisation. However, users may want to have different things (block of content) available for different sites regardless of them having the same structures as the initially customised site. Low-end and mid-range devices may not support large storage of the customisation. In addition, users need to install specific browser and plug-in to use the adaptation engine. Users may not want to install the browser plug-in as found by Xiao et al. (2008).

A customisable mobile device oriented web data extraction scheme has been proposed by Xiao et al. (2008). The customisation engine resides in a proxy server, as from their questionnaire survey they found that most users did not agree to install plug-in on the client devices. Based on the DOM tree, the system splits web page into two layers - link block and the corresponding content block. The engine customises and personalizes content based on a user's browsing history. Xiao et al. propose both customisation and personalisation schemes. First, the system customises pages based on a user's request stored in a database. There is no detailed discussion on this customisation approach. Second, it personalises the page based on the user's browsing behaviour; it reorders the page by displaying those items with the most number of clicks first and then inquires of the user whether to delete those items that were clicked less. Similar to PageTailor, it will deliver content that users want and hide the rest; but the adaptation and customisation is done using AJAX (Asynchronous JavaScript and XML) instead of a browser plug-in. The customisation and personalisation only works if the mobile device supports AJAX as part of the system requires a few AJAX code to run on the client's side. Similar to PageTailor and Highlight, the customisation process involves content and layout adaptation. The system was evaluated for its efficiency (speed) and effectiveness (accuracy) of the splitting mechanism, which showed the system's efficiency and effectiveness are acceptable. A user study was not conducted.

A toolkit to personalize web pages for mobile devices has been proposed by Kao et al. (2009). The concept of the adaptation engine is also similar to PageTailor by Bila et al. (2007) but it requires users to set their preferences through a desktop computer instead of on the client device. The system allows users to determine blocks of content on a web page to be displayed or retained after customisation. The mobile code for the personalisation, called Page Tailor and implemented in JavaScript, is downloaded and executed when users want to personalise (i.e. customise) the page (N.B. this Page Tailor is not the same as the PageTailor developed by Bila et al. discussed earlier, it only has similar name). User preferences for the page are

identified by the XPath expressions of the object or content. Users can specify the preference by selecting blocks of items to retain and altering their order of appearance on the customised page. This is done using the visual manipulation tool provided by Page Tailor code, which manipulated the page through the DOM interface. Filtering the unwanted content reduces the page length, which in turn reduces scrolling. However, to access the customised page, users need to first specify their preferences using a PC or laptop. Then, users need to configure their browser to go through a proxy. If there is no user preferences stored for a page, nothing will happen. No detailed evaluations or user trials were reported. Simple tests conducted showed that the system worked consistently across the two browsers tested (Internet Explorer and Firefox) and was stable - customisation based on users' preferences produced the same blocks of content on different days.

Proteus (Caetano et al., 2007) is a proxy side dynamic adaptation architecture to adapting web pages on small screen devices based on user preferences stored in a profile. The HTML code is validated and unimportant information such as comments are removed. DOM structure is used to represent the page in memory for further actions. Users need to define the format of web page they want, a thumbnail or HTML format. For each block of summarised text, a *more* link is appended at the end of the summary that links to the original text. Proteus allows users to filter images or figures, in which only textual information will be displayed. It allows users to determine the compression rate for images if they decide to display the image. It also adapts a page into a thumbnail or conventional HTML text. All these are done based on users' preferences specified on a form on the web. Preliminary results showed that the system worked as intended. No formal user studies or empirical evaluation was reported.

Many other research efforts focusing on page customisation have been introduced (Anand & Mobasher, 2005; Macías & Paternò, 2008a; Macías & Paternò, 2008b; Nylander et al., 2005; Paternò & Zichittella, 2010; Paternò et al., 2008).

Retaining, as much as possible, the page structure of the adapted page would assist users in browsing the web on their mobile devices.

2.6 Summary

In this chapter, we presented background information on mobile web and mobile device technologies. We also discussed approaches to displaying web pages on mobile devices. Significant research efforts are looking at content adaptation to tailor web pages to mobile devices. Two main groups of adaptation are those that alter the data (format/media type of

content) and those that alter the layout. The adaptation can be performed on the client device, using a proxy, or at the server. In addition, adaptation approaches that consider users' preferences were also discussed.

Generally, there are a few problems with current adaptation approaches.

- Having different versions of websites (manual adaptation) is difficult to maintain and causes inconsistency between versions as experienced and admitted by Facebook (see Section 2.4.1).
- There are users who do not wish to install additional software such as a plug-in on their phone or may not have a specific browser, thus client-side adaptation is not suitable for these users.
- For proxy-side adaptation, users are required to access the proxy first in order to get to the mobile version of web.
- Web developers do not have full control of what will be adapted with both client side and proxy adaptation.
- There has been a lack of empirical research (user trials) conducted. In addition, most evaluation was carried out on emulators which provide an artificial experience for users.

The following chapter will look at the preliminary studies conducted to investigate issues and user expectations of browsing the web on mobile devices.

Chapter 3
Requirements Gathering and Preliminary Studies

This chapter discusses the preliminary studies conducted for this research in order to understand and identify existing problems and requirements for our studies.

Usability and user experience are important issues in determining which types of websites could benefit most from a 'One Web' approach to website design and construction. We conducted a series of surveys and a user trial to identify the types of websites people frequently accessed on their mobile devices and the problems they had encountered. This allowed us to understand and gather users' needs and requirements.

In order to understand the types of websites people frequently accessed and the problems they experienced with viewing web content on their mobile devices, we conducted a survey as described in Section 3.1. The survey showed that social networking sites (SNS) were the type of websites most often used by respondents.

We further investigated which social networking sites people accessed most, the tasks they frequently performed on the social networking site, and problems they had encountered while accessing the site from their mobile devices. This second survey is described in Section 3.2. Results showed that Facebook was the SNS people accessed most.

We then conducted a user trial detailed in Section 3.3 using Facebook to identify the problems faced by users while performing a set of common tasks. The trial was conducted using Facebook on a computer (standard version) and on a mobile device emulator (mobile version). The trial also asked users for their expectations and views of the Facebook mobile version.

Finally, Section 3.4 summarised the findings in this chapter.

3.1 Use of Mobile Devices and Frequently Accessed Websites Survey – Survey 1

To identify the types of websites people accessed, we conducted a survey to find out about the usage of mobile websites (or websites on mobile devices). The main objectives were to compare the types of websites people access from their personal computers (PC) and mobile devices, and the difficulties and problems they have had while accessing the websites from

their mobile devices. In addition, we were also interested in participants' experience with and use of mobile devices.

A set of questionnaires was used in this survey, as these are "a well-established technique for collecting demographic data and users' opinion" (Preece et al., 2002). According to Kurniavski (2003), there are three main categories in survey questions: characteristic, behavioural, and attitudinal.

The survey design and validation process are discussed next and are followed by the discussion about participant recruitment, survey procedure, and results.

3.1.1 Questionnaire Design and Validation

A questionnaire of three sections was designed (see Appendix B.2). The questions were categorized into Demographic Information, Mobile Device, and Mobile Web sections.

Section A – Demographic Information (characteristic data)

The purpose of this section was to gather participants' demographics – their age group and gender. The information was collected to check if there was clear difference between groups. Users differ; therefore, responses - behavioural and attitudinal - might vary between the groups. In addition, this data would allow comparison with other studies.

Section B – Mobile Device (characteristic and behavioural data)

The purpose of the Mobile Device section was to identify participants' usage of mobile devices and basic information about their mobile devices.

We gathered information related to the length of time participants have been using mobile devices, the use of their mobile devices, and basic information about their mobile devices. These questions were designed to provide us the factors that influenced participants' usage and experience of mobile websites using their mobile devices.

Section C – Mobile Web (behavioural and attitudinal data)

The purpose of the Mobile Web section was to identify the types of websites that people usually access from their PC and mobile devices. The section also collected data on any difficulties users have encountered while accessing sites from their mobile devices.

We gathered information related to the length of time and frequency participants have been accessing the web from their mobile devices and the frequency of access for each type of the websites from their PCs and mobile devices. We also gathered information related to

participants' experiences and any difficulties they may have had with the web from their mobile devices and their general opinion on mobile web.

Pilot test

To validate and ensure that the questionnaire was understood and interpreted by participants as intended, it was pre-tested (Kerlinger & Lee, 2000; Kitchenham & Pfleeger, 2002) in a pilot test (Kitchenham & Pfleeger, 2002) involving six students (undergraduate and post-graduate). The pilot test revealed minor misunderstanding with question 9 (see Appendix B.2). Based on the respondents' feedback (through their questions for clarification) the questionnaire was reworded. After a minor modification, we re-tested the questions with the same pilot participants to assess their understanding of the revised question 9.

3.1.2 Participants and Procedure of the Survey

The aim of the survey was to identify the usage and problems of mobile web. The population for the survey were mobile web users. Members of the general public around Lincoln University and Christchurch (such as around the Christchurch City Library, the Cathedral Square, and three telecommunication company retail outlets) were approached and asked if they used their mobile for accessing the web. We only surveyed those who accessed the web from their mobile devices.

Many of those approached did not use the web on their mobile devices. As it was difficult to get participants who accessed the web on their mobile devices, we used two ways of recruiting participants – direct (we approached the participants in person) and indirect (we left sets of surveys with a self-addressed return envelope at the telecommunication company outlets to be distributed to their staff and customers). With the direct method, we surveyed the respondents in person where the participants participated on the spot. When potential respondents were unable to participate in the survey at the time, they were given a set of survey material with a self-addressed return envelope.

Prior to the survey, a Lincoln University Human Ethics approval was obtained. The survey was designed to take around 15 minutes. The survey started with a brief introduction to the survey and participants were also made aware of the consent form and their rights. Then, participants were asked to answer the questionnaire. Participation was voluntary. The survey was conducted in June 2008. Survey responses were stored in and were analysed using Microsoft Excel.

3.1.3 Result and Analysis

We recruited 13 participants by the direct approach; 47 surveys were issued via the indirect approach with nine being returned. Of the nine surveys returned, five were excluded, as they were considered invalid because they were not from participants who had been accessing the web from their mobile devices. We therefore had five valid indirect survey participants. In total, we had responses from 17 respondents to analyse. Given the small sample size, we have not done sub-group analysis by age or gender.

Mobile Phone Usage

Results showed that on average, participants had been using their mobile devices for 7.59 years (*SD* = 2.81 years).

Participants used their mobile devices for a variety of purposes. The majority of the mobile phone usage was for telephony and communication purposes such as for making calls (17 participants), texting (17) and emailing (12). Participants also used their mobile phones for accessing the Internet (13 participants), and non-telephony purposes such as games (11), and for radio and music (5).

A major-use of mobile phones, at this time or the survey, was for communication (Cui & Roto, 2008) with less use being for accessing the web or performing other non-telephony usage.

Types of Websites Access from Personal Computers and Mobile Devices

Results showed that all types of websites were accessed on both PCs and mobile devices. The top five types of websites accessed from both PCs and mobiles were portal and search engines; email; news; chat; and community (e.g. social networking) sites. Figure 3.1 shows the frequency of accessing types of websites on PCs and mobile devices. The frequency was calculated by totalling the score of access frequency times the number of participants.

The frequencies are: several times a day (score = 3); several times a week (score = 2); less than once a week (score = 1); and never (score = 0).

Frequency of access = sum of (score of access frequency x number of participants who select the option).

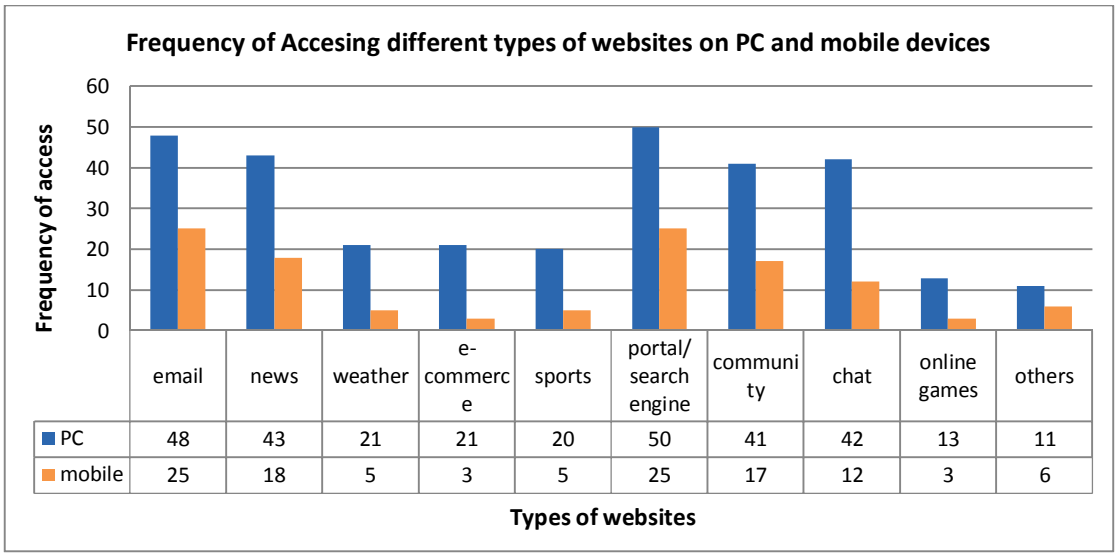


Figure 3.1 Frequency of accessing types of website on PCs and mobiles

Similar findings have been reported by Opera who found that portal/search engines and social networking sites were the top sites accessed from the mobile web (Tetzchner, 2008a, 2008b). Opera also reported an increase in the number of mobile web users (those who use Opera mini), from 11.9 million users in March 2008 to 17.3 million users over five month; and this number is increasing.

Mobile Web Usage and Experience

Of the 17 participants whose responses were valid, four accessed the web several times a day on their mobile devices, seven accessed it several times a week, one accessed it once a week, and the other five accessed the web from their mobile devices less than once a week.

Results showed that participants accessed the web from their mobile devices because it was convenient, practical, time saving, and it can be accessed from anywhere and at anytime.

As described earlier, participants were also asked about problems they had encountered while accessing websites from their mobile devices. Problems reported can be categorised into two main issues – infrastructure (or technology) issues and design (or the site) issues.

Infrastructure issues include slow access and download speeds, and unstable connections causing incomplete download of pages. Half (9) of the participants reported slow download speeds and unstable network connections as the problems they encountered (most often) while accessing their most frequently visited website from their mobile devices.

Design issues include jumbled page layout and content due to restructured page layout (four reports), navigation difficulties (long navigation and scrolling) (four reports), and difficulties with viewing graphics or images during their mobile web access (three reports).

Generally, participants liked the idea of accessing the web from their mobile devices as it offers them the convenience of accessing the web from anywhere and at anytime. Most participants are looking forward to a better experience with web access on their mobile devices. Five of the participants specifically commented that they expected to access web pages with similar content and structure on their mobile devices as pages on the full sites (they would have on their desktop). Appendix B.3 shows a complete analysis of the survey results.

3.2 Social Networking Site Survey – Survey 2

Social Networking Sites have been reported to be gaining popularity worldwide. Opera (2008a) indicates that almost 40% of mobile traffic worldwide is to SNS and in some countries it is almost 60%. ABI Research (2008) reports that nearly half of the social network users have also accessed the site from their mobile. Our survey (Section 3.1.3) supports this finding for New Zealand. Therefore, we decided to concentrate our study on SNS as they account for a large percentage of current web traffic and appeal to a demographic likely to make use of mobile devices for Internet access.

This second survey investigated the tasks people performed most frequently on social networking sites. The problems they had encountered while accessing the sites from their mobile devices were also investigated.

Similar procedures and preparation to Survey 1 (the mobile web survey) were used in this survey. We used a questionnaire to collect the data.

3.2.1 Questionnaire Design and Validation

A questionnaire of two sections was designed (see Appendix C.1). The questions were categorized into Demographic Information and Social Networking Site (SNS) sections.

Section A – Demographic Information

The purpose of this section was to gather participants' demographics – their age group and gender. As in survey 1, the information was collected to allow analysis to discover if there were differences between groups.

Section B – Social Networking Site (SNS)

The purpose of this section was to find out the social networking site people accessed most and the tasks that they performed most frequently on the site.

We gathered information related to the SNSs that people access, the length of time they have used the SNS, the frequency of performing different SNS tasks, and the top five most important tasks they performed on the SNS. We also identified the problems participants have encountered if they accessed the site from their mobile device.

Pilot Test

As in survey 1, we pre-tested the questionnaire in order to validate it and ensure that the questions asked were understood and interpreted as intended, and that it gave us the type of answers that we were looking for (Kerlinger & Lee, 2000; Kitchenham & Pfleeger, 2002). The pre-test was conducted in a pilot test with four students who were users of social networking sites. Based on their feedback we made minor changes of wording to the questions where participants had asked for clarification.

3.2.2 Participants and Procedure

As we were conducting a survey on SNS, the population for the survey were social networking site users. Therefore, we recruited only those people who were users of social networking sites. A similar procedure to that used in Survey 1 (the mobile phones and mobile web usage) was used for this survey. Only the direct approach was used to recruit participants. We approached the general public around Lincoln University and Christchurch and asked whether they were users of social networking sites. In approaching potential respondents, we approached those who were actively using their mobile phones or those who appeared to be at leisure. A few of the participants had also participated in Survey 1.

The survey took around 20 minutes each. As in survey 1, participation was voluntary and survey responses were stored in and were analysed using Microsoft Excel. The survey was carried out in September 2008.

3.2.3 Results and Analysis

There were 28 respondents. Half of the respondents had been using SNSs for more than two years; eight for more than a year and the rest of the respondents for less than a year. Appendix C.2 shows the response data for the survey.

Most Accessed Social Networking Site

Generally, respondents were users of more than one social networking site. Results showed that Facebook was the SNS that was used by most of the respondents (20), followed by Friendster (8), Bebo (6), Multiply (1), MySpace (1), and LinkedIn (1). Other findings from (ABI Research, 2008; Tetzchner, 2008a) also reported that Facebook was among the top SNS accessed worldwide.

Three participants (who were users of Facebook, Friendster, and LinkedIn) accessed the SNS from their mobile devices.

Most Frequently Performed Tasks

The five tasks people performed most frequently on the SNS were read messages or comments, view photos, view friends' pages or profiles, view notifications or updates, and write messages or comments. Figure 3.2 shows participants' frequency of performing tasks on the SNS. Similar calculation to Survey 1 (see Section 3.1.3) was used for the y-axis, and the order for x-axis follows the order of tasks in the questionnaire.

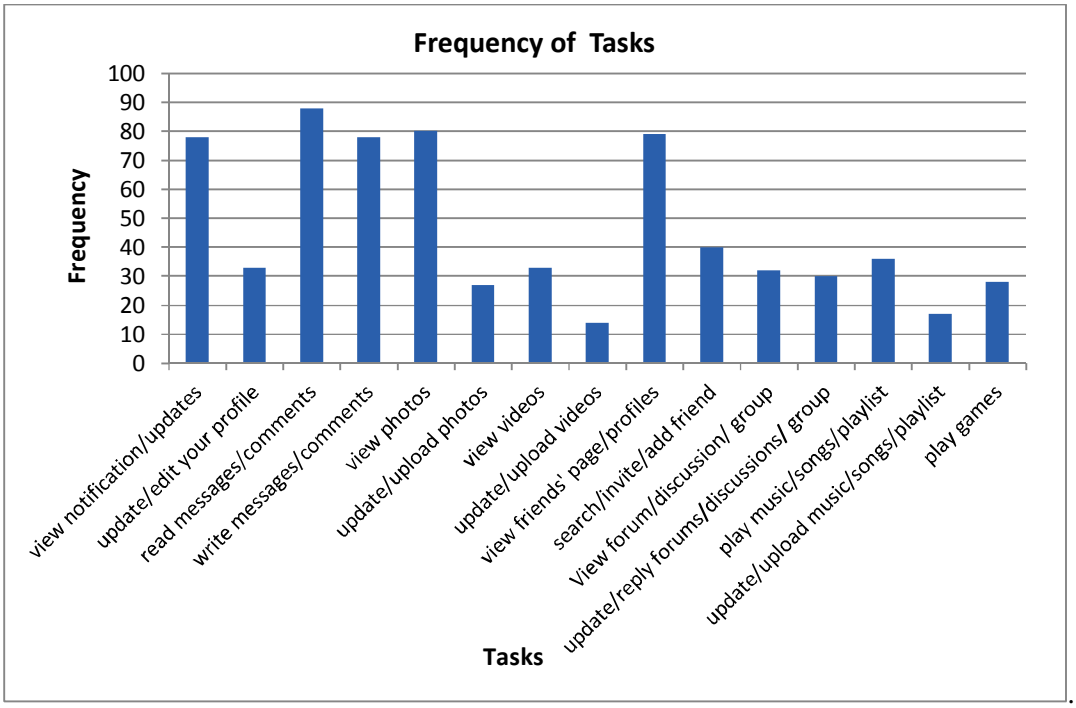


Figure 3.2 Most frequent tasks carried out on social networking sites

Problems with the Social Networking Site on Mobile Devices

The survey showed that most (23) of the participants did not access the SNS from their mobile mainly because of cost, slow download speeds, or they did not have suitable mobile devices. Those that did access the sites from their mobile noted that:

- The small screen causes changes to the format and layout of the sites. In reality, the difference in the format and layout is either because a different version of site is delivered to their mobile (for Facebook and Friendster) or because the respondent's mobile adapted the standard page to fit into the device screen. (LinkedIn only has a mobile site or application for a few types of mobile devices).
- Reading and entering information and text could be difficult.
- Fonts were thought to be too small and graphics unclear.

3.3 Social Networking Site (Facebook) - User Trial

As Facebook was the most used social networking site, we decided to focus our user trial on Facebook. A user trial was conducted to identify problems faced by users while performing a set of the most commonly performed tasks on social networking sites. The trial investigated both the Facebook standard version (full site) and the Facebook mobile version. The aim was to find out how users carried out the tasks frequently performed on SNS and to identify any problems or difficulties they had encountered while accessing the sites from standard and mobile web browsers. We wanted to investigate if people expected both versions to be the same in terms of the design (or layout) and compare the features offered.

Data was collected using an observation and a simplified thinking-aloud protocol (Nielsen, 1993), notes and a survey. A simplified thinking-aloud method was used because data analysis can be done using the notes taken by the researcher (Nielsen, 1993) and because it can give us insight into the thinking of the users. The user trial was conducted in November 2008.

3.3.1 Instrument Design and Validation

The trial required participants to answer a background questionnaire and to perform a set of tasks on both the Facebook full site version and the Facebook mobile version. This section discusses the design and validation of the user tasks.

Questionnaire and Task Design

The user trial required participants to answer a short demographic questionnaire and perform a set of user tasks (See Appendix D.1).

Background Information (Section A)

The aim of the Background Information section was to gather participants' demographics. We gathered information related to participants' age, gender, and duration of being a Facebook member, which may influence the way participants performed the tasks and their overall opinion about Facebook.

User Tasks (Section B)

The purpose of the user tasks was to observe how participants performed the common Facebook tasks using the full site version and the mobile version. We wanted to identify any issues participants have while performing the tasks on each version. Based on the most frequent tasks people performed on SNS (see Section 3.2.3), we designed a set of tasks under five main categories:

1. Read messages/comments
2. Write messages/comments
3. View photos
4. View friend's page/profile
5. View notifications/updates

We also asked about 'Configure Home page' to see if participants were aware of the feature and their opinion of it. We asked this question in order to explore if it is a frequently used feature and whether it is important.

The specific tasks for each category are described further in Section 3.3.3.

Pilot Test

As in the previous surveys, to validate and ensure that the questionnaire was easily understood, and as intended, it was first pre-tested (Kerlinger & Lee, 2000; Kitchenham & Pfleeger, 2002). We conducted a pilot test (Kitchenham & Pfleeger, 2002) involving six students (undergraduate and post-graduate). The pre-test showed that questions gave us the types of answers that we were looking for and that they did not require any changes.

To check whether the task instructions were understood as intended, to estimate the time required to complete the trial, and to test whether we were getting the expected type of answers we conducted a pilot trial (Nielsen, 1993) with two users. The pilot trial revealed that the procedure and material were working as planned.

3.3.2 Participant Recruitment

The population for the user trial were Facebook users. We recruited participants who were Facebook users, aged over 16, for this trial. They were recruited from Lincoln University by direct approach. There are a few debates (Faulkner, 2003; Nielsen, 2000; Spool & Schroeder, 2001; Woolrych & Cockton, 2001) of how many testers (or participants) are enough for finding usability problems: number of problems and classifications of problems. The number of testers depends on, among other things, the research objectives, time, and budget available. For our user trial, considering our objectives, time, and budget constraints we followed Nielsen (2000) suggestion that five users are the minimum number of participants that can identify around 85% of problems. We recruited six participants.

3.3.3 Materials and Procedure of the Trial – Conducting the Pilot Trial

Prior to the trial, we obtained Lincoln University ethics approval.

Materials for the Trial

Two test Facebook accounts (Cik Cuba and Cuba Lagi) were created and used in this user trial so that participants did not have to share their personal information, and to provide control and consistency for the study.

The trial was conducted using a laptop using Internet Explorer 7 web browser for the trial on the Facebook full site.

To test the Facebook mobile site, an online Sony K750 emulator from .mobi[13] was used. An emulator, software that uses the same rendering code as an actual physical device, was considered satisfactory because we wanted to test the display or the look of the site rather than the physical interaction. A Sony K750 emulator was used as the mobile phone was among the most popular mobile phones and represented a mid-range phone able to access the web at the time.

[13] http://mtld.mobi/emulator.php

Procedure for the Trial

The trial started with a briefing session about the study. Participants were made aware of the consent form and their rights and were asked to think aloud while performing the tasks.

In order to keep the trial a reasonable length for participants we split the tasks into two groups as illustrated in Table 3.1.

Table 3.1 Groups of Tasks

Group	Category of Task	Tasks
1	Read messages/comments	- Read the latest personal message from Cuba Lagi. - Read the latest comment from Cuba Lagi on your wall.
	Write messages/comments	- Write a new message to Cuba Lagi - Write a new comment on Cuba Lagi's wall - Reply to the latest comment from Cuba Lagi on your wall
	View photos	- Find out how many photos in *Spring08* album - View the photo titled *purple* from *Spring08* album - Place a comment/tag on the *purple* photo
2	View friend's page/profile	- Find out which friends are currently online - Find Cuba Lagi's current online status - Find how many mutual friends you have with Cuba Lagi
	View notifications/updates	- View current notifications - View your friends' recent activities/updates for the last 2 days

Then, participants were asked to perform the tasks. Participants were given the option to complete all the tasks (from both groups) or only one group of tasks. When participants chose to complete only a group of tasks, we alternated the group of tasks trialled from the previous participant who also performed only a group of tasks.

Participants were asked to perform their tasks on two versions of Facebook: the standard (full site), and the mobile version. Participants performed the tasks on the full site first, then on the mobile site. This is because we were not comparing the two sites but rather trying to determine how the mobile version reflected the standard (full site) version. A similar approach was used by Shrestha (2007) who compares mobile web browsing experience to desktop web browsing. The order of tasks and the versions trialled was not randomised. Participants were observed and notes were taken during this session. After performing the tasks, participants were surveyed for their general comments about the sites.

3.3.4 Results and Analysis

Three participants voluntarily trialled all tasks from group 1 and 2; two trialled only the tasks in group 1, and one trialled the tasks in group 2. We measured and analysed tasks completed, task completion time, and participants' comments.

Number of Completed Tasks

Table 3.2 shows the trial tasks with the number of participants who undertook the tasks and the number that successfully completed them.

Table 3.2 Number of participants who successfully completed tasks on the standard and mobile site

Tasks[14]	No. of participants	Full site	Mobile
1. Read the latest personal message from Cuba Lagi.	5	5	5
2. Read the latest comment from Cuba Lagi on your wall.	5	5	5
3. Write a new message to Cuba Lagi	5	5	2
4. Write a new comment on Cuba Lagi's wall	5	5	5
5. Reply to the latest comment from Cuba Lagi on your wall	5	5	4
6. Find out how many photos in *Spring08* album	5	5	3
7. View the photo titled *purple* from *Spring08* album	5	5	3
8. Place a comment/tag on the *purple* photo	5	5	3
9. Find Cuba Lagi's current online status	4	4	3
10. Find how many mutual friends you have with Cuba Lagi	4	4	0
11. View current notifications.	4	4	4
12. View your friends' recent activities/updates for the last 2 days.	4	4	4

Results showed that all tasks were easily performed and completed on the full site version. However, on the mobile site, while some tasks were similarly easy to complete as on the full site, some were difficult to perform (not completed by more than one participant).

[14] The task to find friends currently online (see **Table 3.1**) was not available for the mobile site; the result for this task was not analysed or discussed.

Easily completed tasks on the mobile site

On the mobile site, only five tasks were easily completed by all participants who attempted them:

a. '*Read the latest personal message from Cuba Lagi*'
b. '*Read the latest comment from Cuba Lagi on your wall*'
c. '*Write a new comment on Cuba Lagi's wall*'
d. '*View current notifications*' and
e. '*View your friends' recent activities/updates for the last 2 days*'.

We believe this is because all these tasks can be clearly found on the mobile Home page as shown in Figure 3.3.

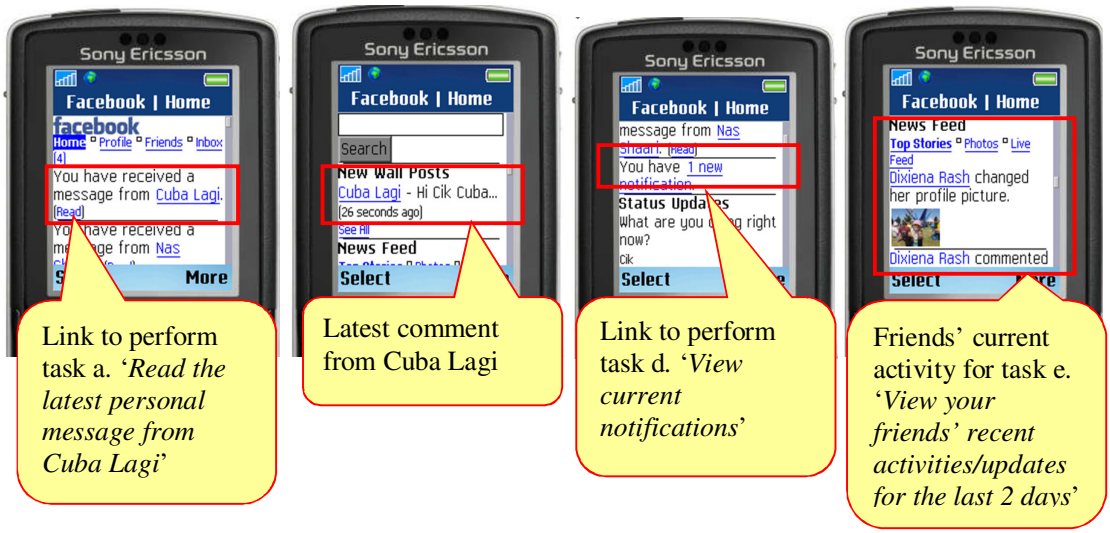


Figure 3.3 Homepage of the Facebook mobile (as scrolled from the top to the bottom of the page)

Difficult tasks on the mobile site

There were three tasks performed on the Facebook mobile version that were unsuccessfully completed and terminated when participants thought they were unable to complete it and wanted to stop. The tasks were:

a. *'Write a new message to Cuba Lagi'*
b. *'Find out how many photos in Spring08 album'*

c. *'Find how many mutual friends you have with Cuba Lagi'*

We look at each of these in turn.

- ***Write a new message to Cuba Lagi***

For the task 'Write a new message to Cuba Lagi', three participants were unable to find a way to complete the task on the mobile site. The link to this task was in a different place and used different term on the mobile site. Three participants were looking for 'Compose Message' and 'Compose New Message' link/feature as on the standard site (Figure 3.4).

Figure 3.4 Links available under 'Inbox' on the standard site

When participants did not find the link in the expected place, they gave up. To write a new message to a friend on the mobile site, the user needs to go to the friend's profile page (e.g. Cuba Lagi's profile) and choose Message (Figure 3.5).

Figure 3.5 Message under friend's profile

- ***Find how many mutual friends you have with Cuba Lagi***

None of the four participants could complete the task 'Find how many mutual friends you have with Cuba Lagi'. This is probably because they expected to find a list of mutual friends available on friend's (Cuba Lagi's) profile page, on a similar location with the same link as in the standard site (Figure 3.6).

Figure 3.6 Friend's (Cuba Lagi's) profile page

Participants were observed to repeatedly go to the Friend and Profile page to check for the link to mutual friends as on the desktop. To perform this task on the mobile site, participants need to go to *Cuba Lagi*'s profile page (click on Cuba Lagi link or search for Cuba Lagi), choose *Cuba's Friends* then, on Cuba Lagi's Friends page choose *Mutual Friends*. A new page will be displayed that will inform the number of friends user have in common with Cuba. Figure 3.7 shows those steps.

Figure 3.7 Steps to find mutual friends

Configure Home Page

Configuring Home page cannot be done on the mobile site. As discussed earlier in Section 3.3.1, we asked this question in order to explore if there already exist a feature that would allow users to customise pages in order to get pages similar to their desktops. Only one participant had configured her home page on the full site and this was to change the position

of boxes with the most frequently used at the top and the least frequent at the bottom. Unable to configure the page on the mobile phone during the trial, the participant voluntarily used her account to check her page on the mobile site. The participant pointed out that the configurations were not reflected in the mobile version. All other participants had not configured their home page on the full site.

Tasks Completion Time

Participants performed, and successfully completed, all tasks faster on the Facebook full site version than on the mobile version. We attribute this, in part, to a greater familiarity with the full site version. Figure 3.8 shows the comparison of task completion time for the full site and the mobile site.

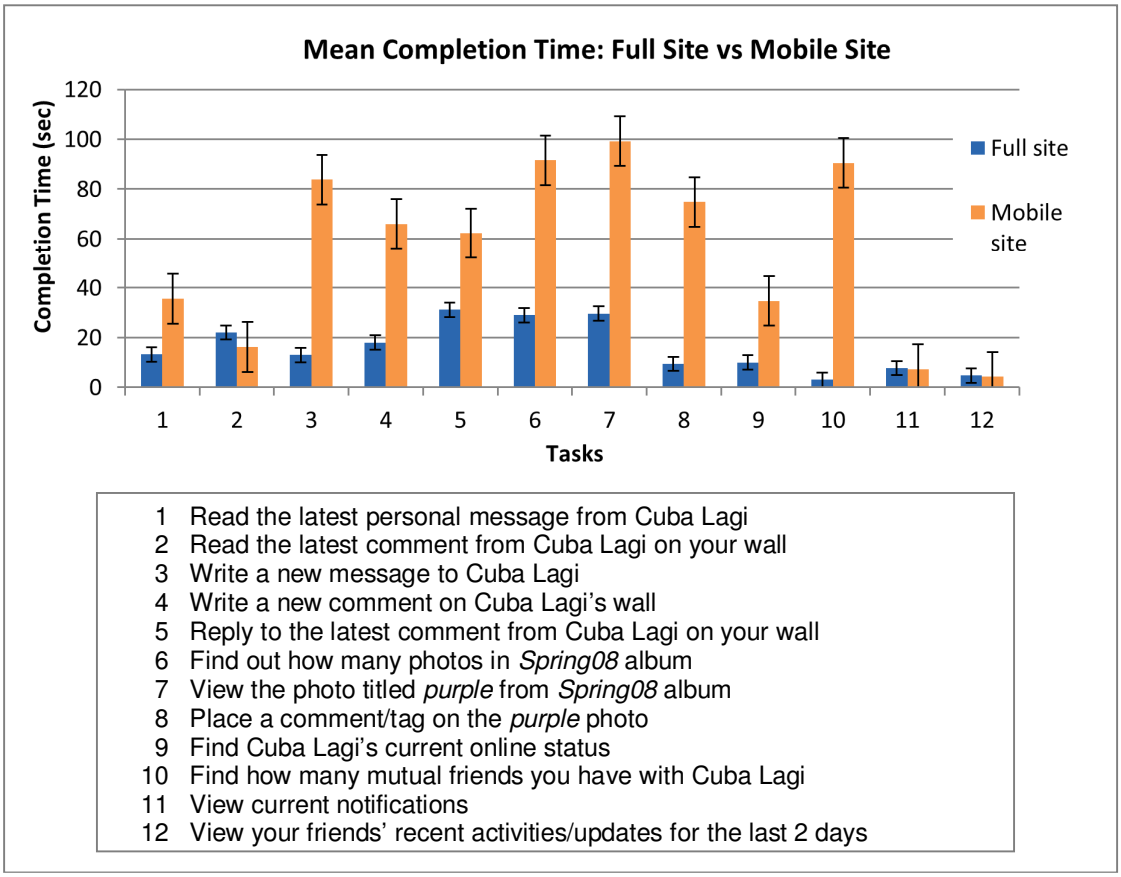


Figure 3.8 The mean task completion time for the full site and mobile site

Task completion time on the mobile site

On the Facebook mobile version, a few participants were unable to complete some of the tasks. On average, all tasks were completed within two minutes. For any attempted but

incompleted task, we considered the time at which the particpants gave up or stopped the task as the completion time as used by Lunn et al. (2008). However, as a few tasks were related to each other, failure to complete one task caused participants to give up on the following related tasks (for example, finding photos in Spring08 album, view purple photo, and place comment/tag). This could affect the mean completion time and conclusion that can be made if participants took longer or shorter time to give up. Thus, we also analysed the result by looking at the mean time for only those successfully completed tasks. Due to the small number of participants, results of analysis are suggestive rather than authoritative.

Figure 3.9 compares mean completion time for all attempts (i.e. completed and incompleted tasks) with mean completion time for those completed tasks only.

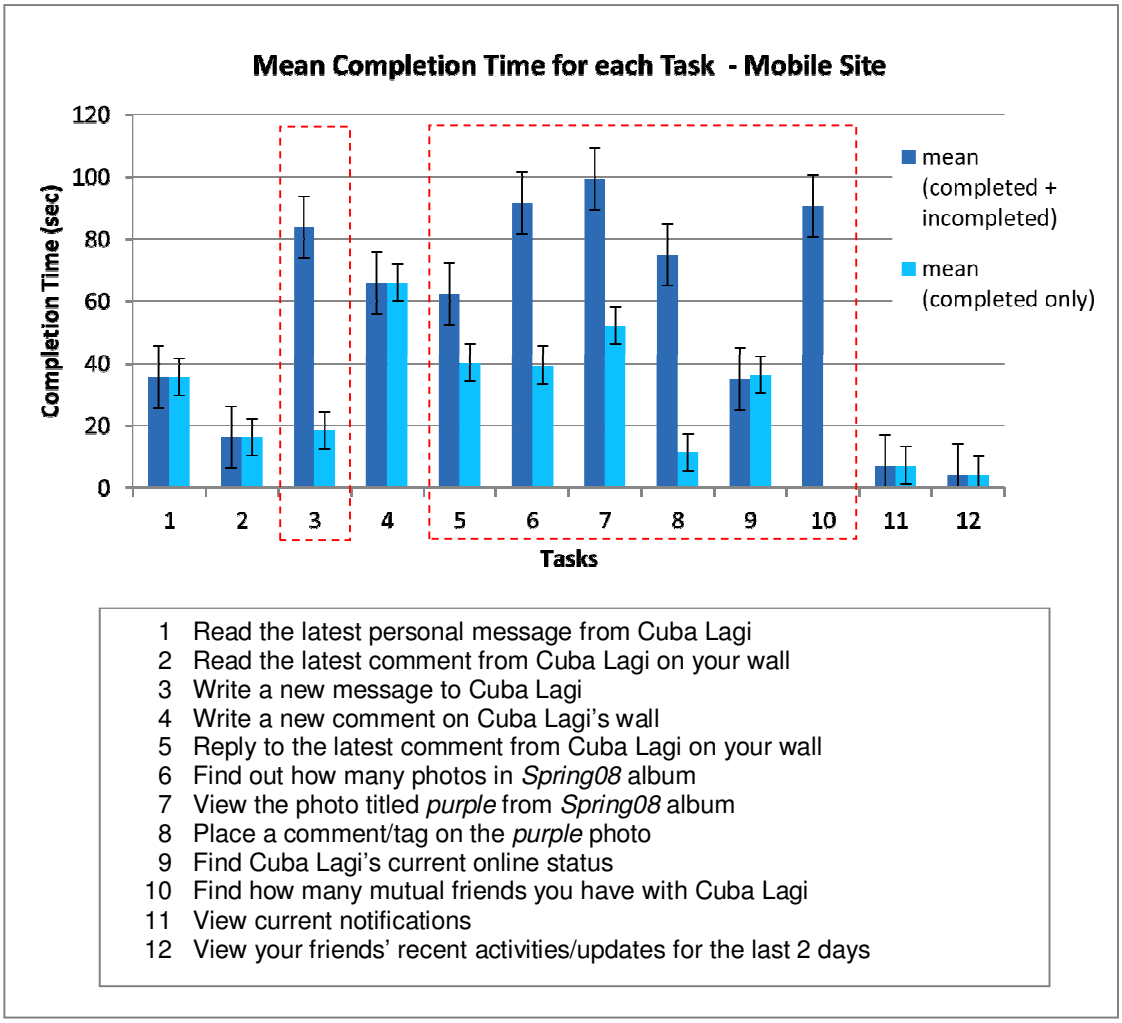


Figure 3.9 The mean task completion time, the dashed rectangles highlight the tasks with at least one unsuccessful completion

Excluding the times for any incompleted task, resulted in a shorter mean completion time than that for all attempts. This lower mean does not imply that the tasks are easy to complete. For example, excluding the time participants gave up for task 3, shows an average of 18.5 seconds, which might be interpreted as an easy task. However, three participants were unable to complete task 3, suggesting that the task was difficult to perform on the mobile and this is reflected by the mean completion time of 83.8 seconds. Similarly, result shows that while participants did attempt task 10 (Find how many mutual friends you have with Cuba Lagi), none were able to complete it.

The time taken to complete each tasks varies between users, and may be due to the level of users' familiarity with the site and the network speed during the trial. The time taken for accessing the mobile site from the emulator may also vary to the time taken using the actual mobile phone.

The time participants gave up also varied. The shortest time participant gave up was 20 second on the task to find mutual friends. A few participants were asked whether they wanted to stop the the task, when they looked frustrated with the task. Generally, we noticed that participants appeared frustrated and gave up the tasks after about two minutes of trying. Appendix D.2.2 shows more analysis of the task completion time.

Participants' Comments

Following the trial tasks, participants were asked to provide general comments about the tasks and their experiences of using both Facebook sites. Five of the participants suggested that it would be better if they could have a version similar to the Facebook full site on their mobile devices. For instance, one participant, P4, commented that the mobile version is "*not user friendly because the contents, tabs and links have been restructured and not organized as on standard*". P2 commented: "*too simple version, very hard to find the functions/links*". P6 commented, "*to have similar features as on standard site, e.g. link to send message, link to comment*".

Findings showed that problems were caused by the site being different in terms of page structures and layout; different words; and different functionality. Participants expected to have similar functions and the same terms used for the mobile version.

3.3.5 Limitations

Limitations to this study need to be acknowledged. The trial was conducted using the 'simplified thinking aloud' and observation. Generally, it was observed that participants were

not familiar with the thinking-aloud protocol. There were times when a few participants 'forgot' to think aloud and preferred to do the tasks in silence and they had to be reminded to think aloud. It was difficult to simultaneously observe and record what users did. Using additional data collection equipment such as voice recorder or video recorder could mitigate this problem.

3.4 Summary

In this chapter we discussed the surveys conducted to identify types of websites people accessed from their mobile phone, the tasks they frequently performed and problems they had encountered while accessing the web from their mobile devices. We also disscussed the user trial conducted to identify problems participants encountered while performing tasks on the Facebook full site and mobile versions.

Participants expected similar content organization and navigation hierarchy on the standard and mobile sites.

The following Table 3.3 summarises the problems participants had encountered and their requirements of a mobile web.

Table 3.3 Summary of problems of the mobile web and users requirements

No	Problems of mobile web	Users requirements
1.	Different structure layout	Preserve structure (page depth/breadth)
2.	Different terminology or naming problems	Same terminology for all devices (versions)
3.	Different items presented for different versions	Similar items for different devices
4.	Different location of items	Similar location of items for different devices
5.	Long navigation (scrolling and navigation path)	Short navigation (scrolling or navigation path)

Based on the findings, we believe a 'One Web' approach to design is an idea that could produce similar output on desktops and mobile devices and help in reducing the problems discussed.

The following chapter will discuss our proposed approach to delivering web pages to different devices focusing in minimising the problems and meeting the requirements identified.

Chapter 4
Proposed Approach

In the previous chapter, we discussed the preliminary studies conducted to investigate problems users encountered while accessing web pages from their mobile devices. In particular, we investigated the Social Networking Site - Facebook.

This chapter discusses our proposed approach to adapting web pages to different devices in order to meet the requirements outlined in Chapter 3 and restated here:

- Preserve structure (page depth/breadth)
- Same terminology for all devices (versions)
- Similar items for all devices
- Similar location of items for all devices
- Short navigation

4.1 Issues with Web on Mobile Devices

Improvements in mobile devices, especially smartphones, PDAs, and tablets mean that the experience of viewing web pages on these devices could be similar to the desktop. However, the limited capabilities of some mobile devices still causes issues with users' experience when browsing website on mobile devices (Gomez, 2010b) especially those websites mainly developed for PC. This section discusses issues with current approaches of delivering and accessing web pages using mobile devices.

4.1.1 Dedicated-Different Versions of Pages for Mobile Devices

One approach to delivering web pages to mobile devices is to develop a dedicated separate version of mobile site for mobile devices as employed by sites such as Facebook and Air New Zealand. This ensures that the pages are suitable for viewing on mobile devices. However, this approach causes a few issues.

- For the developers any update needs to be implemented multiple times, once for each different version of the pages. This is especially onerous if the sites have different versions of mobile sites for different types of mobile devices with varying capabilities.

Facebook has acknowledged the issue that maintaining multiple versions of sites is difficult and that it causes inconsistency between versions (see Section 2.4.1).

- An update in one version might not be available on the other version(s) (see Section 2.4.1). For the users, this can cause confusion if there is inconsistency with the full site or other mobile versions. For instance, our previous user trial revealed that the inconsistency of the location of certain items such as mutual friends between the Facebook standard site and the Facebook mobile site caused problems (see Section 3.3.4).

In short, having multiple versions of websites for different devices can cause confusion for the users and issues in maintaining the sites for the developers, particularly if the sites are frequently changed or updated.

4.1.2 Adaptation of Web Pages for Mobile Devices

Another approach to ensuring good viewing experiences on different devices uses adaptation techniques to reduce, customise, and adapt web pages for mobile devices. As discussed in Section 2.5, most of the adaptation engines proposed are meant (or only tested) for smart phones or PDAs. Some adaptation engines require the use of particular mobile browsers. In the case of client-side adaptation, specific types of mobile browsers or mobile devices are required, thus not all web capable mobile phones could benefit from the adaption. Among the issues with the existing adaptation methods are that the adaptation engines:

- Re-segment or re-construct the initial page structure after adaptation by splitting the page into new subpages. This method reduces the need for long scrolling within a page. However, it also increases and adds to the hierarchical depth of the page. Having to go through more pages may cause users more clicking and loss of orientation within the overall site.
- Present only a summary of content. This technique reduces the size of content on the page and allows users to find something they are looking for quickly. However, users have to navigate back and forth from the main page to access the full content.

4.2 Proposed Approach

Findings of our studies discussed in Chapter 3 showed that problems users encountered while accessing the web from their mobile could be categorised into two areas: design and infrastructure. Design issues include the different page appearance (structure, layout, and

terms used), and the extra navigation to get to the required content compared to the standard page accessed from the desktop. The infrastructure issues reported in our studies include slow access and download speed, which may be influenced by the device and network capabilities.

This study will focus on solutions that address the problems users encountered in the design area. We do not address infrastructure issues. The design problems may be due to one or more factors:

- **Page structure of dedicated mobile version**

  For many sites, the mobile version has a different overall page structure (different location of items) and different terms from the standard page for desktop viewing. This may cause the users confusion in finding the content, and require long scrolling and navigation through several levels to get to the right items or links. The mobile version may not be updated consistently with the standard version, resulting in different content; this may also confuse users.

- **Automatic adaptation or transcoding**

  In many situations, the page displayed on the mobile device is the outcome of an adaptation or transcoding engine, or the client browser auto adapting the page for the mobile device. This may result in jumbled page layout or content, cause confusion and increase navigation. The way content is delivered or structured may not be what users want and may cause frustration. The content may also be altered in ways the designers of the site had not anticipated.

Despite encountering problems, users are keen to access websites from mobile devices. Results from our previous study (section 3.3.4) showed that users want to have pages on their mobile devices that are similar in content and structure to those on the desktops.

We propose a solution to the following requirements determined from our earlier studies:

a. **Ensure a similar page structure is delivered on all devices**

   If the page structures are similar between devices then users will be able to use familiar navigation pathways to find their items of interest. This will facilitate the ease of navigation.

b. **Ensure consistency of terms used and the location of items on all devices**

   Having the same terms used under the same section (or for the main items) will prevent confusion as users swap between devices.

c. **Minimise items displayed and reduce navigating within a page**

   Displaying only the contents users require reduces the page size. This could reduce the scrolling and navigation required with the smaller screen and users could get to the required content more quickly.

d. **Support users visiting on multiple different devices**

   Users have different devices and requirements, which may change over time. Being able to choose the items displayed based on the devices and requirements should improve their experience on the web.

To meet these requirements, we propose a server-side adaptation by prioritisation as an approach to adapt web pages to users' needs. The adaption will not change the overall page structure but will allow some items to be removed. As discussed in Section 2.5.2, the adaptation can be done on the device, on a proxy server, or on the server. We chose a server-side adaptation for the following reasons:

- The adaptation for devices is done automatically and works for any device regardless of the browser. The mobile device does not have to download the whole page first, which reduces the amount of data transfer. The adaptation does not require local processing, therefore, it reduces time taken to display, saves CPU (power and usage), and possibly battery life.
- Installing a specific browser on the device or using a proxy server is not required. Users do not have to configure their device to first connect to a proxy.
- Developers can control the adaptation as the page and prioritisation engine are on the same server.

Adaptation by prioritisation will allow users to prioritise page items that they want to display on a device. Users can set priority for each item (1 for high priority, larger numbers for lower priority). Low priority items would be removed from the page. This prioritisation will allow users to determine, for each device, what they want to display, and in which order. Users can always change their preferences.

For those sites that may be browsed casually using a mobile device, where users do not have their preferences set, default priorities set by the developer would allow initial adaptation that a user could then customise.

The prioritisation system will involve the following phases:

a. Users can set preferences for items of interest and the priority level at which items will be shown per page for each device.

b. The prioritisation engine reads the user preferences. If users have not set preferences, the system will use the default preferences set by the website developers for the device.

c. The prioritisation engine applies the preferences to each item, reorders the items according to the preferred items' ranking and displays the prioritised page.

This method ensures that users have control of preferences. It also ensures that developers (or any stakeholders of the website development) can determine the items (or content) that are "prioritisable" so as not to interfere with the overall objectives of the page.

The prioritisation engine allows the overall structure of the page to be maintained on every version. The engine does not introduce new segments or subpages that would increase page depth and change navigation paths. The displayed items will be the same as on the full site to provide familiarity to users.

By default, multimedia content such as images will be delivered unchanged. Transformation rules and other media content adaptation approaches to handling the adaptation, for example, to omit/delete, compress, or convert the image could be implemented but are outside the scope of this study.

4.3 Structuring of Pages for Prioritisation

In (X)HTML *div* is the structural element used to separate the page into different sections and to control the page layout. This is common practice for many websites and is employed in sites such as Yahoo![15], Google[16], and Stuff[17].

We have chosen to develop an engine that will prioritise pages with a structure based on *div* tags (which will be referred to as adaptive pages or the base page). Any item or web content that might be prioritised would need to be constructed with a *div*. A *div* node can have other element nodes as its children. A *div* could also have other *div*s or other elements nested within it.

[15] http://nz.yahoo.com/
[16] http://www.google.co.nz
[17] http://www.stuff.co.nz/

The *div* tag is the child node of <body>. The <body> and <head> tags are the two child elements of the <html>. Only the text or elements under the tag <body> are the visible page content and are modifiable. The other elements under the <head> would not be modified by the prioritisation engine. Figure 4.1 illustrates the hierarchy and relationship between element nodes.

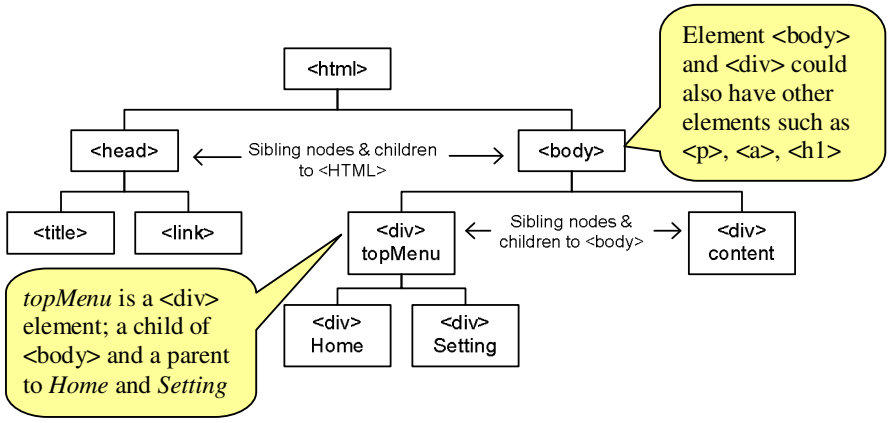


Figure 4.1 An example of a HTML hierarchy

In this chapter, any *div* or web content that could be prioritised will be referred to as a prioritisable item.

4.4 Storage of Preferences

There are a number of ways and places to store users' preferences. These preferences need to be preserved across visits. Therefore, we will need persistent storage that is reliable and easily accessible so users can use their specified preferences regardless of the device they are using. The approach to storing and managing users' preferences will be further discussed in the next chapter.

4.5 System Overview

The goal of the prioritisation is to ensure that content is preserved, the overall layout (in terms of the parent-child relationship) is maintained, items look the same as on the original page, and the overall look and feel of the original page preserved. Our prioritisation maintains all the items and their hierarchies but allows users to specify the number and order of the items displayed on different devices.

Figure 4.2 shows an overview of the prioritising process.

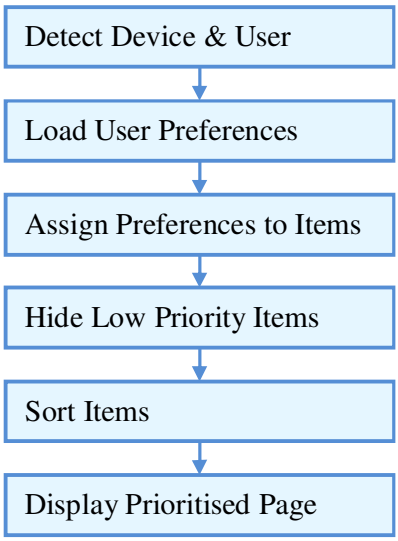


Figure 4.2 Overview of the Prioritisation system

The aim of the Prioritisation system is to display a page according to each item's priority. The user will be able to give each item a priority. Items with lower priority are removed, and the remaining items are reordered to form the final prioritised page.

4.5.1 Detect Device and User

Prioritising the page items depends on the user's preferences and the device used to access the page. The prioritisation engine should be able to identify the user, device, and the page requested.

4.5.2 Load Preferences

For each browsing session of a page, the prioritisation engine will load the user's preferences based on the type of device requesting it.

We anticipate their being two types of user: anonymous/unregistered users and known/registered users. Anonymous users will automatically get default preferences. Registered user will get prioritisation based on their specified preferences.

In addition, the prioritisation engine will record a cutoff value for a particular user on a particular device. The cutoff value is used to control the items to be displayed on a device.

The prioritisation engine should remove items whose preference value is greater than the cutoff and a new 'more...' link will be inserted on the page.

4.5.3 Prioritise and Display Items

Based on the user's preferences, the prioritisation engine will reorder the items on the page. To do this, the prioritisation engine needs to assign preferences to prioritisable items; remove those items that are without a preference or whose preference is greater than the cutoff; and sort and display the remaining items. The prioritisation engine should also display all other non-prioritisable items unchanged.

To ensure that those items that are removed remain accessible to users, we propose adding an extra link 'more...' to pages where items have been removed. Clicking this link will then display the page without these items removed.

4.6 Scenario Example

For any given (X)HTML page structured based on *div* tags, the prioritisation engine should be able to display the items based on the preferences assigned and the cutoff level. For example, Figure 4.3(a) illustrates a page that users would get on a desktop before prioritisation. The box shows the users' preferences. For example item i1 has a preference value of 4, item i5 a preference value of 1. The cut off has been set to 5. Figure 4.3 (b) shows the page displayed after prioritisation. Items with a preference greater than five (i3, i4, and i6) and items without a user preference (i7 and i9) are removed in the prioritisation and a new link 'more...' is inserted.

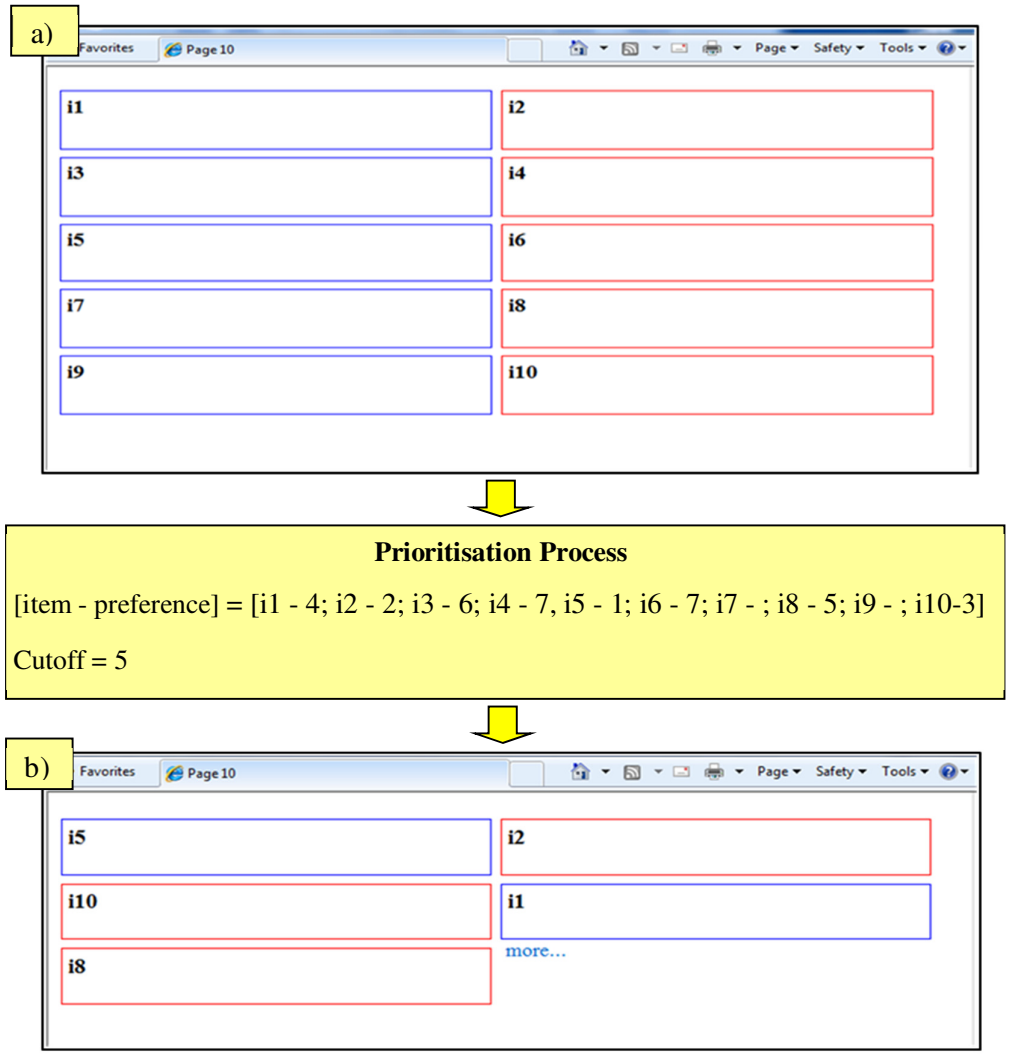


Figure 4.3 a) The initial page and b) the page after prioritisation

The user may have different preferences for different devices.

4.7 Summary

In this chapter, we have summarised the rationale for adapting web pages for different devices based on the concept of prioritisation. This chapter has set out requirements and presented an overview of the proposed approach. The proposed prioritisation approach will preserve the content and general layout (or hierarchy) of the website. The approach can reduce the content displayed for easier access to the most important content.

The following chapter will discuss the implementation of the prioritisation system to deliver pages to multiple devices. This will ensure that users get pages with similar page structure,

terminology, content, and location of content for different devices while only seeing the content most relevant for that device.

Chapter 5
Prioritisation Implementation

In the previous chapter, an overview of the proposed Prioritisation engine to adapt web pages for different devices was presented. This chapter details the implementation of the Prioritisation engine.

First, we summarise the prioritisation concept in Section 5.1. Then, next sections cover the process of identifying prioritisable elements (Section 5.2); an overview of the prioritisation engine (Section 5.3); the modes of storing and managing the data (Section 5.4); the preparation of the XSLT rules (Section 5.5); and the construction of the Prioritisation engine (Section 5.6). Next, we discuss the strengths and weaknesses of the Prioritisation engine (Section 5.7). Finally, Section 5.8 summarises this chapter.

5.1 Background

As described in section 4.2, we propose a server-side adaptation by prioritisation that would allow adaptive pages (see Section 4.3) to be prioritised based on users' preferences. Having a single version of a site that can be accessed using different devices reduces the problems caused by multiple versions of sites. Only one version of a web page needs to be developed and maintained. A prioritisation engine will then prioritise subsets of items to be displayed on a device based on user preferences.

We are focusing on an approach that would minimise the quantity of content (or items) delivered to mobile devices. Other adaptation such as media adaptation (manipulating images and other media) is not addressed at this stage but could be added in the future.

The prioritisation engine will adapt a base page by:

- reordering items based on their priority
- delivering and showing the content of interest based on priority
- removing the rest other low priority content using a 'more...' link
- providing default preferences to users based on the device requesting the page

The prioritisation engine will preserve the general structure of the page ensuring parent-child relationships are preserved after prioritisation. The overall look and feel might have minor changes after items are reordered based on the users' preferences or the adaptation approach of the client's browser. The implementation of the prioritisation engine will be discussed in detail in Section 5.6.

5.2 Identifying Prioritisable Elements

As discussed in Section 4.3, we are focusing on (X)HTML pages with a structure based on *div* elements. These pages could also include other programming scripts such as JavaScript. The implementation of these scripts in an (X)HTML page is out of the scope of this study.

A base HTML page with a structure based on *div* tags was developed to test and discuss the prioritisation engine in this chapter. A Cascading Style Sheet (CSS)[18] was used to control the layout presentation. Figure 5.1 shows the base page, and its initial HTML code with blocks of items structured using *div* tags.

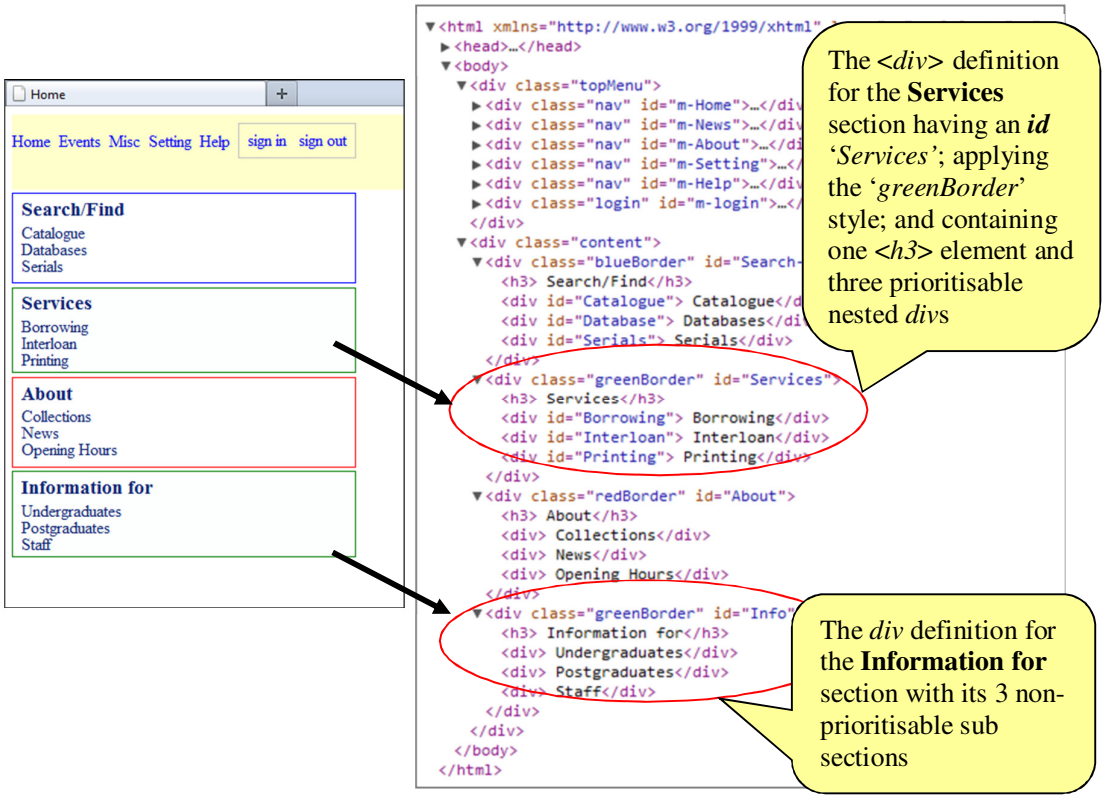


Figure 5.1 The base page and its HTML structure

[18] http://www.w3.org/Style/CSS/Overview.en.html

Each prioritisable item must be a *div* that has an attribute *id*. The attribute *id* acts as a unique identifier for the item within a page. Multiple pages may use the same *id* value for their *div* element. For example, page *Home* and page *About* may both have an element with *id* value '*related_link*', therefore, a combination of a page ID and element ID a required to uniquely define a *div* within a site. This prioritisable *div* will also be referred to as a page item.

Non-prioritisable *div*s will remain in the prioritised page and will assume higher priority and be displayed first among its prioritisable siblings.

Each *div* could also have *div*s or other elements nested within it. In order to manipulate and prioritise the *div*s, we introduced a new attribute *rank* to the prioritisable *div*s. The values for the pair of *id* and *rank* are stored in a database (see Section 5.4).

5.3 Overview of the Prioritisation Engine

The engine has been developed in PHP with a combination of programmatic manipulation and XSLT to update, reorder and display pages. PHP is a server side scripting language that is used to read and write files, and to process XML based documents to be distributed through HTTP. It is fast, stable, secure, easy to use, open source, and integrates with many database engines. Figure 5.2 illustrates the overview of the prioritisation engine.

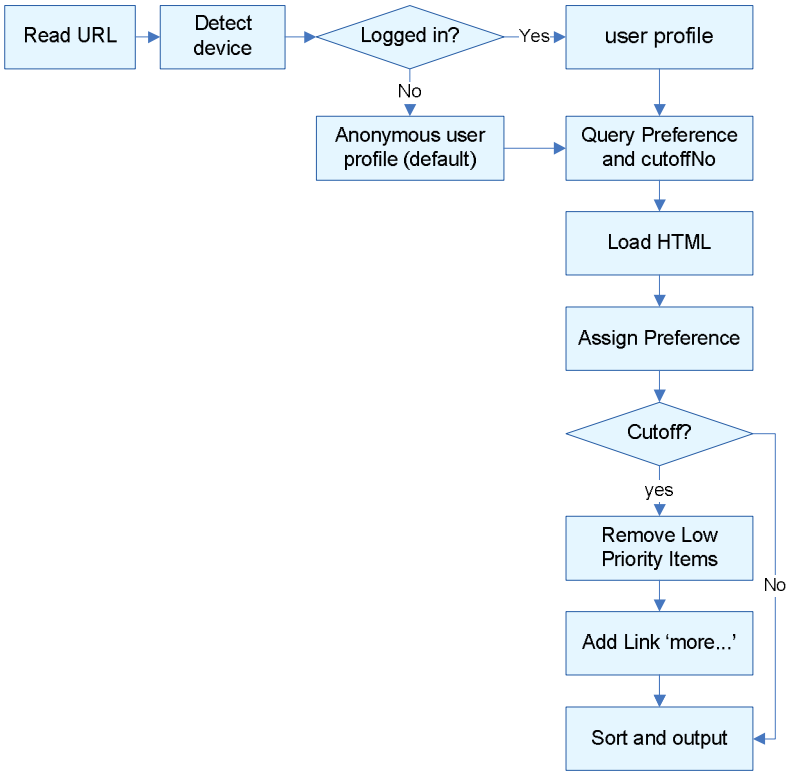


Figure 5.2 Overview of the prioritising system

The construction of the prioritisation engine will be discussed in Section 5.6.

5.4 Storing and Managing the Data

Users' preferences need to be stored permanently, in a reliable mechanism that allows for fast retrieval and which are easily accessible by the Prioritisation engine. In addition, we need to store the user ID and device ID for a browsing session. Three approaches were considered and examined in detail. User preferences could be stored in cookies, session variables, or in databases.

We chose a relational database to store and manage users' preferences and profiles. This approach allows the preferences to be stored permanently and offers a reliable and flexible storage mechanism. A database offers flexibility and scalibilty in terms of adding and managing records for a large number of users. A database also offers flexibility in changing attributes and their values. Managing changes to users' preferences are easy. In addition, storing users' profiles and preferences in a database allows users to access the page from any device (and still able to get their prefrences) without having to set preferences for the new device.

The two other approaches, using cookies and session variables, were considered but were rejected. Cookies stored in a user device need to be sent to the web server every time the device accesses the page. Thus, storing many preferences in them could waste bandwidth. Most mobiles have cookie size limits, so storing all a user's preferences in cookies may not be possible. Storing preferences in cookies is not suitable for mobile devices with limited memory or processing power, which may not support cookies or only support limited numbers. However, storing preferences in cookies could work with desktop browsers but would not provide the require flexibility. Cookies have a 4 kB limit on desktops.

The other approach to storing user preferences would be to use session variables. Sessions are stored on the server and users or clients cannot modify them. Sessions use a small cookie to provide a unique identifier for each client. Most mobiles will be able to store these small cookies. Preferences stored in sessions, however, are not persistent so the preferences would be unavailable once the session is terminated or expired, or when the cookie that holds the session id is deleted from the client browser.

Having decided to use a database for storing user preferences we designed one which consists of six tables as illustrated in Figure 5.3.

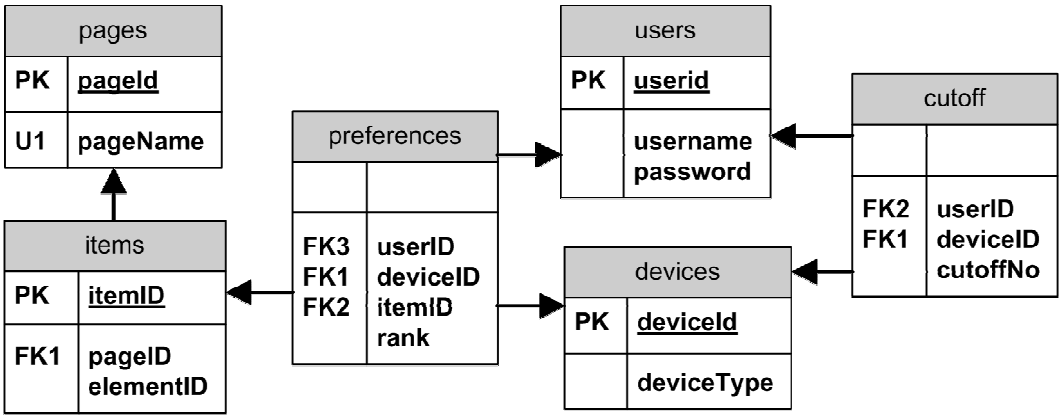


Figure 5.3 Database diagram illustrating tables used to store details required for the prioritisation

Pages - Stores a unique page name and its associated pageID assigned by the database for every page. The page name is the name of each base page, for example, *home.php* or *about.php* identified through the URL variable passed to the prioritisation system.

As well as the page name, the absolute or relative URL could also be stored and must be unique. Storing the absolute or relative URL might cause issues when the directory or folder in which the page is located is modified.

Items – Stores the itemID, pageID, and elementID for each item (*div*) that is prioritisable. The elementID is the value of the attribute *id* for a prioritisable *div*. The itemID is an ID given to a unique combination of elementID and pageID. For a page to conform to the (X)HTML specification, the elementID must be unique in the page (W3C, 1999a). However, multiple pages might use the same elementID. For example, page *Home* and page *About* might both have element ID with value '*Search-Find'* but with the item ID set to 1 and 17 respectively as illustrated in Figure 5.4.

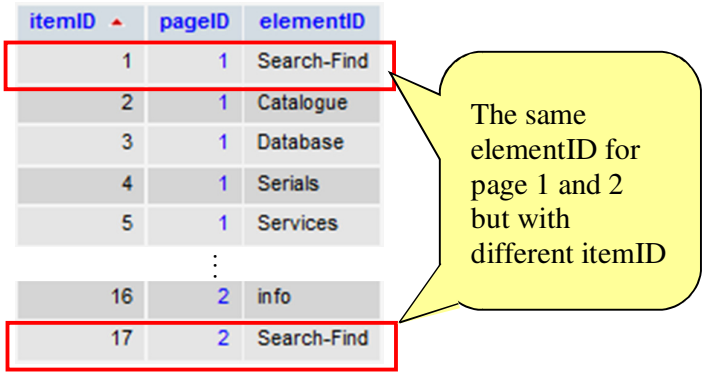


Figure 5.4 Items table

Preferences - Stores the preference for specific items for a particular user on a particular device. It also stores the default preferences for each type of device available in the Devices table. Figure 5.5 illustrates some typical data in the Preferences table.

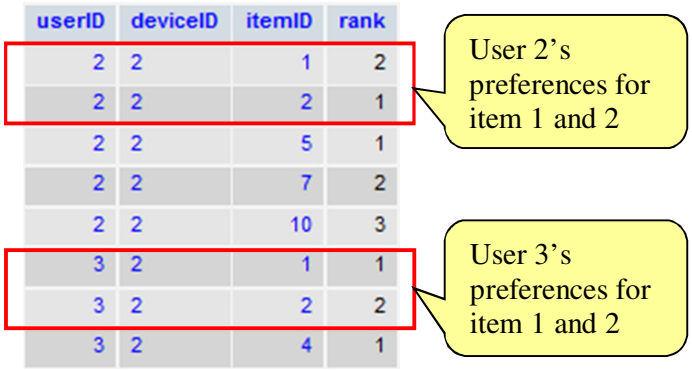


Figure 5.5 Preferences table

The Preferences table above shows that User 2 ranked item with itemID 1 as 2 for his mobile (deviceID = 2), and User 3 ranked the same item as 1 for her mobile. Rank is the priority values starting from 1 indicating the highest priority. Multiple items could have the same priority value, in which they will be displayed according to the order they appear in the initial HTML tree.

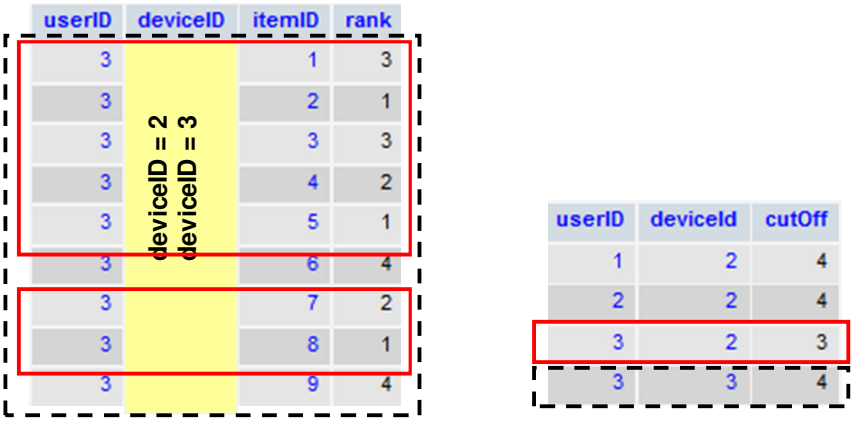
Users - Stores a unique user ID for a username and a password for each user. A userID of 1 is used for default users - unregistered (or guest) users.

Devices - Stores a device type and a device ID for each type of device. For example, the device type could be a desktop, tablet, iPhone, or mobile phone. This design allows for new type of devices to be added as they enter the market.

Cutoff - Stores the number of maximum preference value for a specific user on a particular device. As discussed in Section 4.5.2, only items with the preferences less than or equal to the cuttoff will be displayed in the prioritised page, items with preferences (or rank) greater than the cutoff will be removed on the prioritised page.

Example of User Preferences

Users can specify different preferences for different devices with different cutoff numbers. Figure 5.6 shows that User 3 has specified the same preferences for device 2 and 3 but different cutoff values. User 3 will get only the items in the solid-border red rectangles when accessing the page on device 2 with the cutoff set to 3. In contrast, User 3 will have all the items (item 1-9 in the dashed-border rectangle) displayed on the device when accessing the page on device 3 with the cutoff set to 4.



userID	deviceID	itemID	rank
3	deviceID = 2 deviceID = 3	1	3
3		2	1
3		3	3
3		4	2
3		5	1
3		6	4
3		7	2
3		8	1
3		9	4

a) Preferences table

userID	deviceId	cutOff
1	2	4
2	2	4
3	2	3
3	3	4

b) cutoff table

Figure 5.6 Set of preferences and cutoff

5.5 Preparing/Creating the XSLT Stylesheet

To sort and transform the page into the final prioritised version, we use XSLT transformation rules. It is possible to change the structure of an XML document and transform the document

into another format by applying XSLT stylesheet(s) to the document (W3C, 2007). Figure 5.7 illustrates the transformation of the structure of a source tree into another structure.

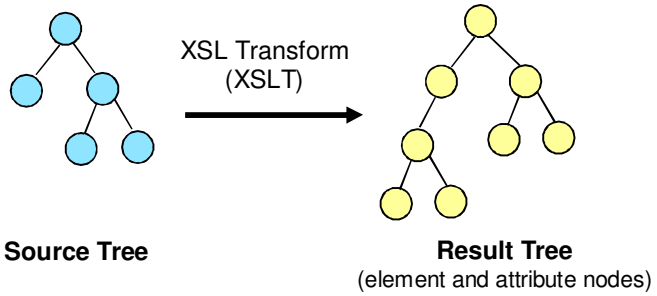


Figure 5.7 The use of XSLT to format or transform a page
Source: http://www.w3.org/TR/xsl/

We created an XSLT stylesheet for the transformation. The stylesheet consists of rules or templates for sorting the prioritisable *div*s and copying other elements unchanged, in order to ensure that the page structure (parent-child relationships), scripts, and styles embedded within an element are preserved in the final prioritised page.

For example, we have an identity copy template that copies everything - nodes and attributes - from the source tree to the output tree as illustrated in Figure 5.8.

```
<xsl:template match='node()|@*' >
    <xsl:copy>
        <xsl:apply-templates select='node()|@*' />
    </xsl:copy>
</xsl:template>
```

Figure 5.8 Template for identity copy

This template is applicable to the whole tree unless there are other specific rules/templates that override it. It will copy everything (such as page items and scripts), including those that are not prioritised to preserve the overall parent-child relationship (structure and layout).

Currently, the stylesheet for the Prioritisation engine has templates to:

- Identity copy – copy all elements unchanged in order to preserve the structure and layout as much as possible

- Sort – sort items or *div*s based on their rank attribute (the preference) in ascending order

- Remove comment – remove comments initially in the source tree

The XSLT stylesheet is extensible. Additional transformation rules or templates can be added when required. For instance, rules to transform an image to an alt text or to remove the image could be added. Appendix E.1 shows the full XSLT stylesheet.

5.6 Constructing the Prioritisation Engine

This section discusses the implementation of each phase in the prioritisation engine. We will use User 3's preferences for device 2 as shown in Figure 5.6 to illustrate the discussion in this section.

5.6.1 Identifying the User, Device, and Page

The prioritisation system needs to identify the user, device, and the page in order to query the user's preferences from the database for the prioritisation process. In addition to the database, sessions are used in the prioritisation system to hold the user ID and device ID across pages once the identification process has been completed. This section discusses the identification processes.

The Login Process

There are two types of users: guest and registered users (as discussed in Section 4.5.2). Registered users have their individual profile stored in the database, whereas guest users will use default profile stored in the database. Figure 5.9 illustrates the login process that users go through to retrieve their profile.

A login page was developed to test the functionality of the user identification process. It requires users to specify their username and password. After the users enter their username and password, the system verifies them against the data stored in the database. Once the username and password are verified as valid, the system will retrieve the user ID for the user from the database. The user ID will be stored in a session variable and passed through to the prioritisation engine to be used throughout the user's browsing session.

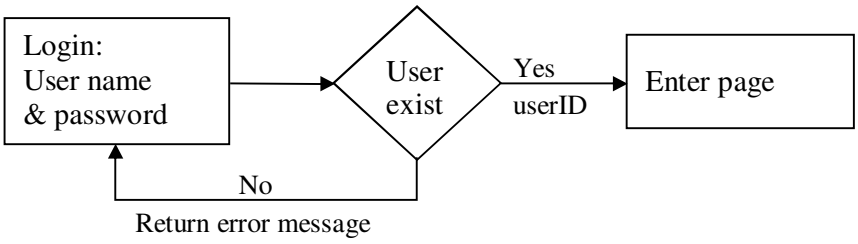


Figure 5.9 The login process for registered users

Identifying the User, Device, and Page Process

Once a user is identified and their user ID is passed through to the session variable. The prioritisation system checks the session variable for the userID. If there is no session variable passed, the system assigns the user with a default userID set to 1 as illustrated in Figure 5.10.

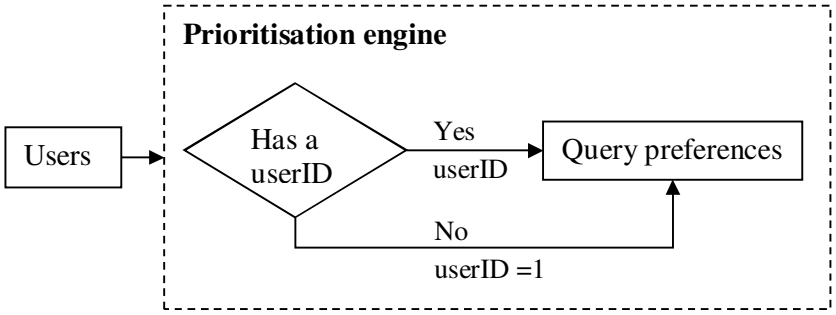


Figure 5.10 The process of identifying users

Next, in order to identify the device type, the system checks the user agent string received from the device. Currently, for the prioritisation system, we have hard coded a list of user agent strings for types of device in the system. The user agent string could also be stored in the database so that as new devices or browsers (with new user agent string) enter the market new rows can be added to the table.

For our research, this approach is adequate but means that user's preferences set for other types of devices are not easily made applicable to the new type of device.

Alternatively, we could use the open source WURFL API (*WURFL*, 2008) or the commercial deviceAtlas API (*Device Atlas*, 2009) to retrieve device information. To use this API, a few additional processes need to be run to populate the database and configuration needs to be

done on the server. If new devices are introduced, a patch file needs to be downloaded. The use of this API is considered future work.

The Prioritisation system identifies the page to be prioritised from the URL variable passed in. If there is a URL variable declared, the system uses the value as the page name. Otherwise, the system assigns *'home'* as the page name.

The system stores the user ID and device type in session variables for use throughout the browsing session.

5.6.2 Querying Users' Preferences from the Database

Once the prioritisation system has identified the user, device, and the page, it queries the database for prioritisable items and user's preferences for the page. It also queries user's cutoff number for the device.

Queries of prioritisable items and user's preferences are done once when the page is requested and the data are stored in arrays for use throughout the prioritisation process. The prioritisation system queries the database for all elementIDs of prioritisable items of a page using the page name identified earlier and stores them in an array *pageItem.*

Then, the prioritisation engine queries user's preferences for the page (*elementID*s and their *rank*s) using the userID, device type, and page name and stores them in another array (an associative array) *userPreference*.

For example, to prioritise page 1 for User 3 with a set of preferences illustrated in Figure 5.6a, the prioritisation engine will query the required data and store them in the following arrays:

pageItem = (Search-Find, Catalogue, Database, Serials, Services, ...)

userPreferences = (Search-Find => 3, Catalogue => 1, Database => 3, ..., About => 4).

Storing data in the arrays allows the system to access them quickly during the prioritisation process.

Alternatively, querying preferences from the database could be done one at a time in which the database is queried each time a *div* is found during the update preference process to check if the *div* is a prioritisable *div.* If it is, the system needs to execute another query to retrieve the preference set for the *div*. This approach would introduce larger overhead to the prioritisation process.

For registered users, if there are no preferences set for them, the system performs another query with a userID set to 1 to get the default rankings for a particular page and device. For example, if User 3 does not have preferences set for his iPhone, a default page set for the iPhone will be retrieved. This method requires two queries. A stored procedure to handle this type of conditional query could be an alternative to perform only a single query. It is expected that stored procedure could improve the performance.

For anonymous users, the system automatically queries the default preferences.

Then, the system queries user's cutoff numbers for the type of device being used.

5.6.3 Updating the Items' Preference

As the Prioritisation system is performing adaptation based on sections or *div*s of the web page, the system first needs to identify the prioritisable blocks of *div*s in the page.

In PHP, two XML parsers could be used to access data: the Simple API for XML (SAX) or the Document Object Model (DOM) (Wandschneider, 2006).

We use the DOM parser, a tree traversal API, in order to access and manipulate the elements of the page. A DOM parser is suitable for parsing hierarchical data and it allows adding or creating new elements to the tree. It loads the whole tree in memory, thus accessing a random node is possible. It is also suitable for use with XSLT. For a very large document, using the DOM parser would require a large amount of memory to load the document.

Alternatively, using a SAX parser, an event or stream-based parser, may not be as memory intensive as using the DOM parser. It can handle large documents. However, SAX cannot modify the XML document being processed. In addition, it does not allow random access of data.

Loading the Base Page

The Prioritisation system loads the page into a HTML DOM node tree. All viewable content and prioritisable items of a web page are child nodes of the element <body> (see Section 4.3). The initial <html> root element and the <head> element are non-prioritisable items and are copied to the final page as is. Therefore, we will illustrate only the node tree starting from the

element <body> in this chapter. Figure 5.11 illustrates the node tree for the initial base page without any preferences assigned.

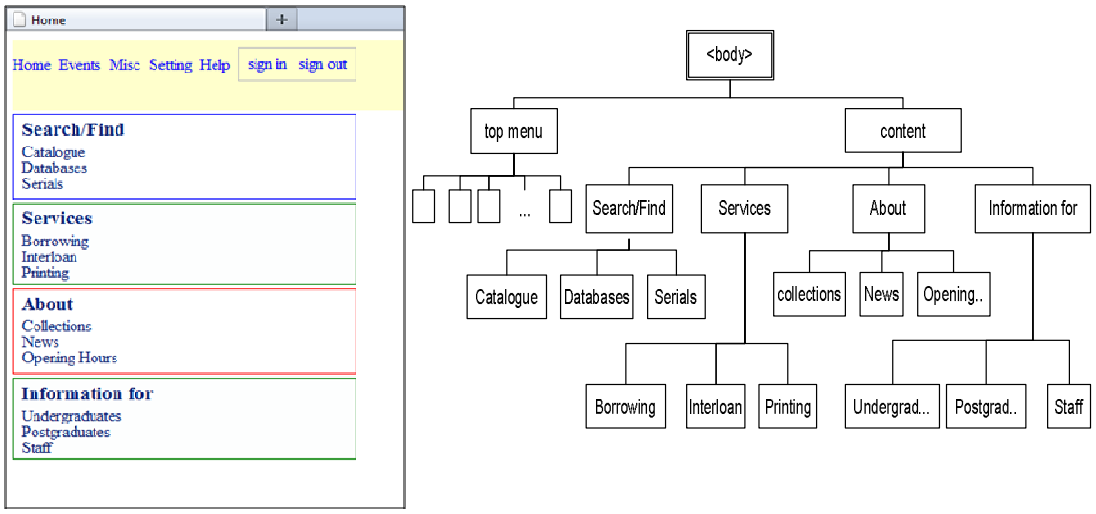


Figure 5.11 The HTML tree for the initial page

Assigning Preferences

After the raw (or base) page is loaded, the system assigns the preferences to the prioritisable *div*s. To achieve this, the system traverses the node tree to check for every *div* element. First, the system examines if the *div* is a prioritisable item. A prioritisable *div* is a *div* with an attribute *id*.

For every prioritisable *div*, the system checks if the *div* is a specified 'prioritisable' item from the array *pageItem* and whether it has a preference declared in the array *userPreferences* described in Section 5.6.2. If the *div*'s *id* is in the *pageItem* array, the system creates a new attribute *rank* for the *div*. Then, the system assigns the attribute *rank* with its value from the *userPreferences* array. Otherwise, if the *div*'s *id* is not in the *userPreferences* array, the attribute *rank* is assigned with a default low priority preference (i.e. 777). The default low priority preference could also be set to any other number deemed appropriate. For this implementation, the minimum value for this default low preference should be equal to or greater than the total number of all prioritisable items in the page. As the number of prioritisable items between pages may vary, a 'large' number such as 777 is used. It is unlikely that a page would have more items than this number.

Each *div* tag that will be prioritised should now have attributes *id* and *rank*. Figure 5.12 illustrates the example of the page's node tree for User 3's assigned preferences indicated by number in the yellow shaded boxes.

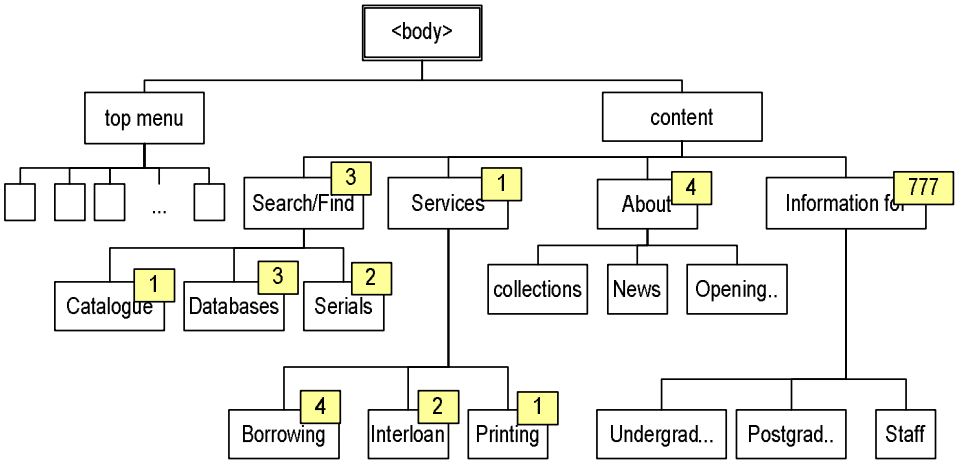


Figure 5.12 The page with assigned preference (number in yellow boxes) for each prioritisable item

The number of *divs* (or items) with assigned preferences from the *userPreferences* array is also referred to as the number of preferences in a page.

Removing Low Priority Items and Adding the 'more...' Link

After the prioritisable items are assigned with the user's preferences, the next step is to remove lower priority items from the final display. In this phase, the system removes the low priority items and adds the 'more...' link. Removing items to hide on the page depends on the cutoff number set by users.

To remove the low priority items, the system traverses the node tree (with the assigned preferences) and removes all the *div*s whose *rank*s are greater than the cutoff number. Then, the system creates a new element *div* to place the hyperlink '*more…*'. The link '*more...*' is created within a new *div* and this *div* is given a *rank* value equal to the cutoff number so that it will be displayed at the end of every page. Page developers (or any stakeholders involve in the page development) could change the *rank*'s value for this *div* to another value in order to change its location.

Otherwise, if there is no cutoff number, no items are removed. Figure 5.13 illustrates the node tree with low priority items removed and a new element *div* added (i.e. the 'more...' link) for a User 3 on device 2 with the cutoff number set to 3.

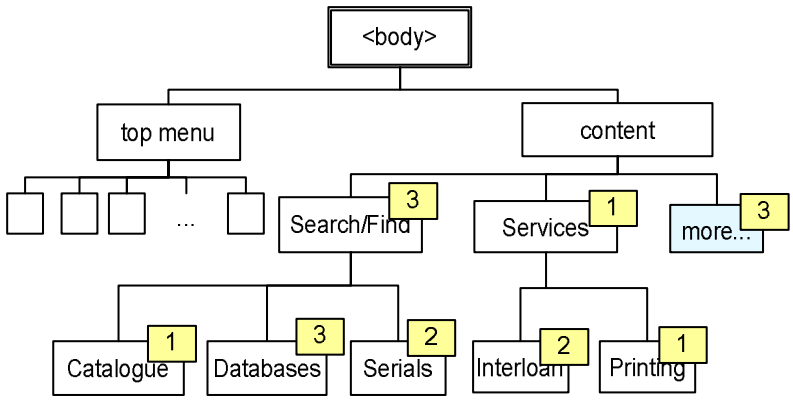


Figure 5.13 The node tree after the removal of low priority items with a new element 'more...' added

Removing any parent node removes all the dependent child nodes.

5.6.4 Sorting and Displaying the Prioritised Page

After the removal of the low priority items, the system reconstructs the page by re-ordering the page items according to their priority and transforming it into the final prioritised page.

In order to re-order and transform the page, an XSLT processor is used. The new tree after the removal of low priority items is then sorted based on the value of attribute *rank* in ascending order by applying the rules in XSLT stylesheet discussed in Section 5.5. The *div*s are sorted for each level of depth relative to other *div*s at the level (nested *div*s are also sorted within the parents). Items with highest priority (value of 1) are displayed first. If multiple *div*s on the same hierarchical level share the same preference, they are displayed in the order of which they initially appear in the HTML tree. All other elements are copied unchanged. The final prioritised page is illustrated in Figure 5.14.

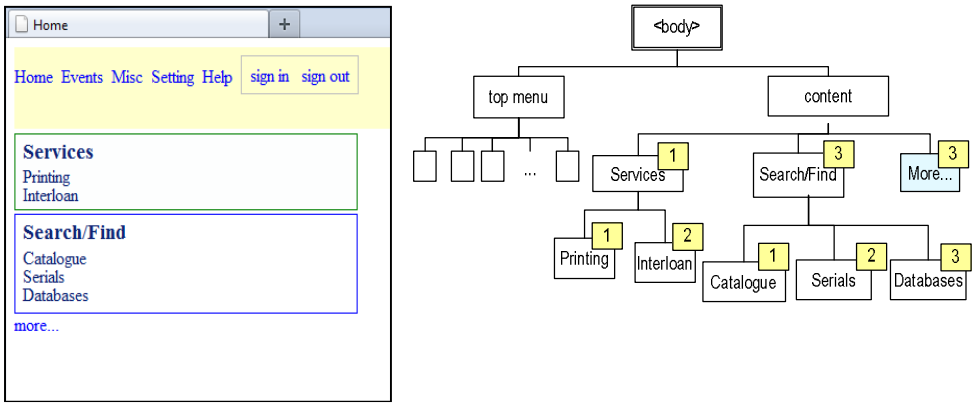


Figure 5.14 The final prioritised page and its node tree

5.7 Strengths and Weaknesses of the Prioritisation Engine

The engine described in this chapter is a proof-of-concept design and has focused on the core engine of the prioritisation system. Other possible customisation features such as the user interface to customise the page was not the focus. We will discuss the performance of the system in Chapter 8. This section discusses the strengths and weaknesses of the Prioritisation engine.

- **The use of DOM parser**

As discussed earlier, there are different ways to process XML based documents in PHP: using SAX or DOM. For a very large document, using a DOM parser would require a large amount of memory to load the whole document. However, it allows easy manipulation of data. Documents could be traversed back and forwards.

Using a SAX parser may not be as memory intensive as using the DOM parser, however, it cannot directly modify the XML document being processed. The document could not be traversed back and forth and random access of data is not allowed. Commonly, the use of SAX parser to modify an XML document is used together with the DOM parser to complement each other.

- **Device detection**

Since we only use the user agent string to determine the connecting device, we do not have information about the capabilities. The engine does not include an adaptation based on device capabilities. Detecting the capabilities of a device may produce a better adaptation for each device. Extra code and rules to deal with different devices could be added. For example, when

the system detects that a device does not support images, the system could apply a different XSLT stylesheet. This approach would require multiple stylesheets to be created.

Alternatively, we could have a stylesheet with comprehensive rules to cater for the device features sent by the system.

- **The XSLT rules**

The rules in the XSLT stylesheet used for the prioritisation engine ensure that pages being prioritised are preserved as much as possible by retaining the parent-child relationship between nodes or items. Additional scripts and stylesheets (for example, CSS files) are copied as is. As described earlier in Section 5.5, the XSLT stylesheet is extensible. For a more thorough content and media adaptation, other rules to manipulate the content or media could be added.

- **Adaptation focusing on structure adaptation**

The prioritisation engine focuses on preserving the structure of the page. The parent-child relationships between elements are preserved after the prioritisation. The prioritisation system focuses on adapting the page based on user preferences, in which the orders of items are changed and certain items are removed. This approach may result in a change in the overall layout. The overall layout may also be slightly changed depending on the clients' browsers.

- **The use of *div*s with *id*s to determine the prioritisable items**

For the prioritisation system to work as intended, every *div* with an attribute *id* should have an *id* stored in the database so that it could be prioritised. It also works on the assumption that every sibling of a prioritisable *div* is also a prioritisable *div*.

Having a *div* with an attribute *id* that is only used as the CSS selector (*id* is not stored on the database) or having a *div* without an attribute *id* at the same level as other *div*s with an attribute *id*, would cause an issue with the prioritised page. These *divs* (without an *id*) assume a high priority (equals to 0) and are reordered when the page is sorted, appearing above those *div*s with an *id*. Ideally, these *div*s should remain in their original location. This type of *div* is usually used to control the presentation structure; therefore, there might be an unintended change in the layout of the page.

Figure 5.15 illustrates the scenario. Only item1 and item3 are prioritisable items whose *id*s and preferences are stored in the database and item2 is a non-prioritisable item whose attribute *id* acts only as the CSS selector.

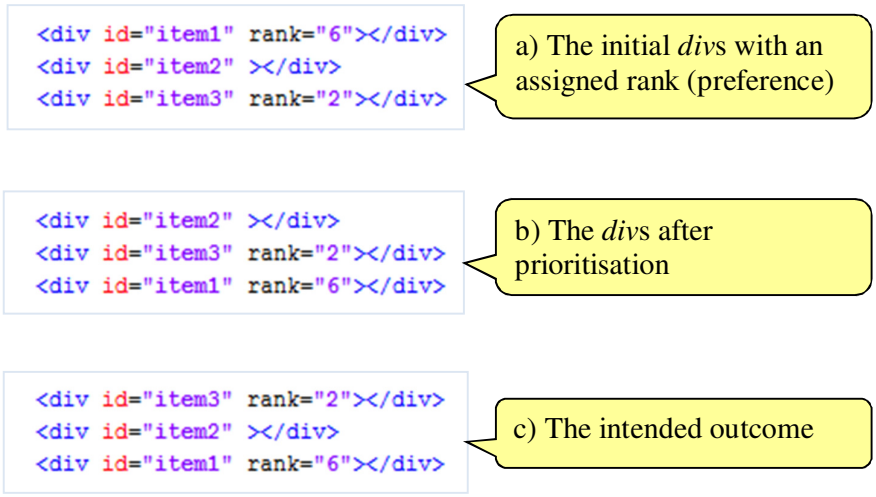


Figure 5.15 Example of *div*s after prioritisation

- **Browser's adaptation capability**

The final layout of the prioritised page still depends on the device's browser. Some browsers may have adaptation features, which would alter the final rendering of the page in addition to the changes made by the prioritisation engine.

5.8 Summary

This chapter discussed the implementation of the prioritisation engine - a prioritisation approach to adapting adaptive pages developed for desktops and prioritised for mobile devices. The prioritisation will ensure consistency of page structure and content, although being accessed from different devices. It delivers only the items of interest to users with higher priority items being displayed first, and removes the rest of items. In addition, the prioritisation engine will preserve the parent-child relationships between items, while changing the order of items on the page. This will allow users to use knowledge of the page structure and the item ordering to navigate prioritised sites.

The following chapters will discuss the user trials conducted to investigate the usability of the prioritised pages and the evaluation done to evaluate the performance of the prioritisation engine.

Chapter 6
User Trial - Method and Design

In the previous chapter, we discussed the development of the prioritisation engine. The engine was developed as a server-side adaptation through prioritisation system.

This chapter discusses the design of user trials conducted to evaluate the usability and user experience of the prioritised web pages for desktops and mobile devices produced by the prioritisation engine.

6.1 Overview and Purpose of the Trials

As discussed in Chapter 3, users found having two versions of Facebook (mobile and full site) that differed in structure and content to be confusing and expected to have a similar structure on their mobile as on the desktop. In these trials, we will investigate the use of a version of page developed for the desktop but also prioritised for a mobile device to answer our research question:

> *Can an adaptive page and prioritisation approach tailor web pages adequately for users with different preferences and devices?*

The user trials aimed to evaluate whether the pages produced from the prioritisation process tailored for different devices could offer a similar or better user experience to websites developed independently for different devices.

In addition, the studies also aimed to answer the following questions:

- Do participants like the prioritisation concept?
- Is there an agreement among participants for the most important tasks and the number of items to have on a page?

It should be noted that we were not testing the usability of the sites, rather, we were conducting specific trials to compare our mock full and prioritised versions with the existing Facebook versions (full site and mobile). A few usability and user experience attributes and measures discussed in Section 2.2. are used and are further discussed in Section 6.9.

In order to test our prioritisation engine, we replicated a few pages of the Facebook full site as our base adaptive page version to test against the actual Facebook full site version and the

actual Facebook mobile version. The replicated pages have a similar page structure, look and feel and have basic navigation and interaction functionality (see section 6.3.3).

These user trials consist of two studies. Study 1, conducted on a mobile phone, investigated participants' user experience with the Prioritised version of our mock page compared to the actual Facebook mobile version available at the time of the trial.

Study 2 evaluated the ease of use of the full mock Facebook page compared with the actual Facebook full site version available at the time.

Except where noted the studies were conducted in the same manner and are discussed together below.

6.2 Method

We used a mixed methods approach for both studies that incorporated observation, user testing, survey, and interview. Mixed methods were used to expand the analysis by combining the strength of both qualitative and quantitative methods (Johnson & Onwuegbuzie, 2004). To validate our data and results, triangulation of both qualitative and quantitative data was performed (Barnes & Vidgen, 2006; Creswell, 1998; Onwuegbuzie & Leech, 2007). Triangulation of data means the use of multiple and different sources, methods, to provide supporting evidence (Creswell, 1998). For our case, it is used to support and corroborate findings (qualitative and quantitative data from the completion time, completed tasks, observation, survey, and interview).

Data were collected using a survey and questionnaire, observation and think aloud protocol, and semi-structured interview. Sessions were audio recorded. After each of the sessions, they were immediately transcribed and coded for analysis. Figure 6.1 provides an overview of the trial process.

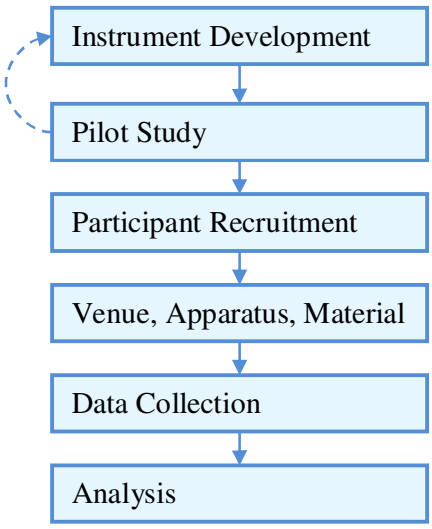


Figure 6.1 Overview of the trial design

We will discuss each of these phases in the following sections.

6.3 Instrument Development - Survey and Tasks Design

This section details the design of trial instruments used in our user trials.

6.3.1 Background Questionnaire

The background questionnaire was used to gather participants' demographics, information on their mobile devices and mobile web browsing habits, and their Facebook experience.

The questionnaire was divided into three sections: Demographic Information, Mobile Web Experience, and Facebook Experience (see Appendix F.1).

- **Part 1 Demographics Information**

The purpose of the Demographic Information section was to gather participants' demographics. We gathered information about participants' age and gender. While not central to our main research question, we collected this information in case any differences were apparent between groups of participants.

- **Part 2 Mobile Web Experience**

The purpose of the Mobile Web Experience part was to gather background information on participants' mobile device and their mobile and web experience.

We decided to use the Samsung F480 touch screen phone because it has only one interaction method (touch-screen); we evaluated participants' experience and their level of confidence with touch-screen mobile phones.

We also asked about their mobile web browsing frequency. Participants' level of confidence with touch-screen phones and their mobile web browsing habits may influence how they perform in the tasks and their opinions on the web pages versions they tested.

We also included questions from the previous survey (see Section 3.1) about the participants' knowledge of their phone capabilities.

- **Part 3 Facebook Experience**

The purpose of the Facebook Experience section was to find out the participants' Facebook experience and the tasks that participants think are important to have when accessing Facebook from each device.

Participants were given a list of 20 tasks and asked to rank their level of importance for the desktop and the mobile device. Participants could also add their own tasks. Then, based on the list of tasks, participants were asked to nominate the five most important tasks to do on each device.

This information would provide guidance for setting up default pages for different devices. We were interested to know if there was agreement among the participants as to the importance of different tasks.

6.3.2 Familiarisation with the Mobile

The familiarisation with the mobile phase applied to only Study 1. For Study 2, participants did not require a familiarisation phase, as they are already familiar with the desktop/laptop.

The aim of the "familiarisation with the mobile" phase was to acquaint participants with the mobile and web browsing. This was done from the realization that not everyone is used to a touch screen phone and that there are different types of touch screen phones with different interaction styles. Participants also needed some familiarisation with a page with similar characteristics to the test pages.

First, participants were given an information sheet explaining the familiarisation process (see Appendix F.2). Then, participants were shown a "training site" and the researcher

demonstrated scrolling and selecting actions. Participants were also shown the browser displaying the practice/training web pages.

To get familiar with browsing the site and the mobile device the participants were given three practice tasks, which they could try with the help of the researcher. The tasks were designed to familiarise participants with interacting with the web page - in particular with scrolling and selecting activities. Table 6.1 summarizes each test task and its rationale. Participants were given around five minutes and were left to explore until they were comfortable with the phone and page. Participants were allowed to ask questions and seek clarification about things they were unsure with.

Table 6.1 Tasks for familiarisation activities

Task	Aims
Click on any links	- to familiarise participants with selecting and clicking links - to let participants explore the page
Click on the "more..." link to see the hidden (removed) information	- to demonstrate the concept of revealing removed information - to familiarise participants with scrolling (the 'more' link is at the bottom of the page) - to familiarise participants with selecting and clicking
Post something on the Events page	- to familiarise participants with inputting text, scrolling, and selecting - to familiarise participants with interaction with the web page

6.3.3 User Tasks

The purpose of the user test was to observe how participants performed tasks on our prioritised pages compared with the actual Facebook pages developed independently for desktops and mobile devices.

We compared prioritised version of our mock pages to the actual Facebook mobile pages (Study 1) and full version of our mock pages to the actual Facebook full site pages (Study 2).

As discussed in the previous chapter, the prioritisation involves some items being removed and replaced with the 'more...' link, and the location of other items being reordered. Based on this, we wanted to investigate whether participants, on the versions trialled and compared, could:

1. locate the commonly used tasks on the pages
2. use the 'more...' link to reveal removed items

We also wanted to gauge the ease of use and the participants' thoughts about the different versions.

Choosing the Tasks for User Test

To help us evaluate the items mentioned earlier, we chose three tasks from the set of most frequent tasks found in our previous survey (see Section 3.2.3). The six most frequent of tasks thought important by participants in the survey were: read messages or comments; write messages or comments; view photos; view friends' page or profile; view notification or update; and invite/search friends. From these tasks, we selected tasks that were related to locating information/content and writing/interacting with the site. In addition, we wanted each of the following criteria to be met by at least one task:

1. Located at the top of both pages
2. Difficult to find in Facebook mobile
3. Hidden (removed) behind 'more…' link in the Prioritised version

To meet the above criteria, we constructed the following tasks and scenarios.

1. Task 1

   A task that is visible and located near the top of the Prioritised version and the actual Facebook mobile version. The feature is visible and is located at the top of both the full mock site version and the actual Facebook full site version. For participants to perform this task, we gave the following scenario:

   Cik Cuba has been busy with other projects, which have kept her away from Facebook for a few days. She wants her friends to know this. Demonstrate and explain how she would update her status.

2. Task 2

   A task that is located higher up and is visible on the Prioritised version but is located lower down or is difficult to find on the actual Facebook mobile version. The task is located in the main menu area at the top of both the full mock version and the actual Facebook full site version. For this task, we gave the following scenario:

   Cik Cuba wants to add Amy as a new Facebook friend, but she doesn't know her email address. Demonstrate and explain how she would find Amy.

3. Task 3

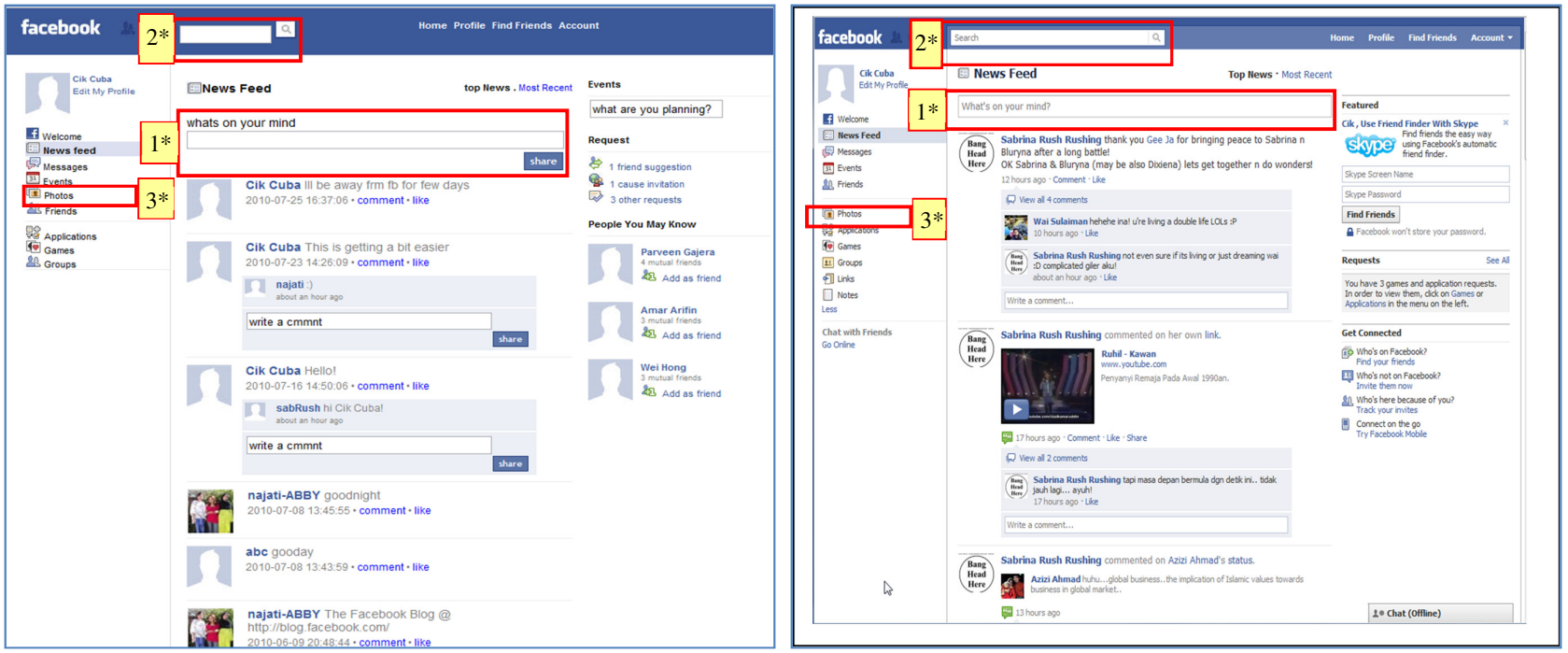
   A task that is initially removed on the Prioritised version but visible on the bottom group of links on the actual Facebook mobile version. The task should be visible on the full mock version and the actual Facebook full site version. For this task, we gave the following scenario:

   Cik Cuba wants to show her friends her photos. Demonstrate and explain how she would navigate to the page that shows her photo albums (Cik Cuba's album).

In addition, the three tasks were also designed to evaluate the accessibility and availability of items in the versions trialled.

Setting up the Pages to Test

To test our tasks, we mocked-up the Facebook full site pages as our default pages. These pages will be referred to as the full mock version later in this thesis. We added a few updates and comments for a fictitious user (Cik Cuba). Figure 6.2 illustrates the full mock version Home page and the actual Facebook full site Home page for user Cik Cuba, and the location of each task on both sites. It should be noted that these tasks could also be performed on other pages of the full mock version and the Facebook full site. These two pages were compared in study 2.



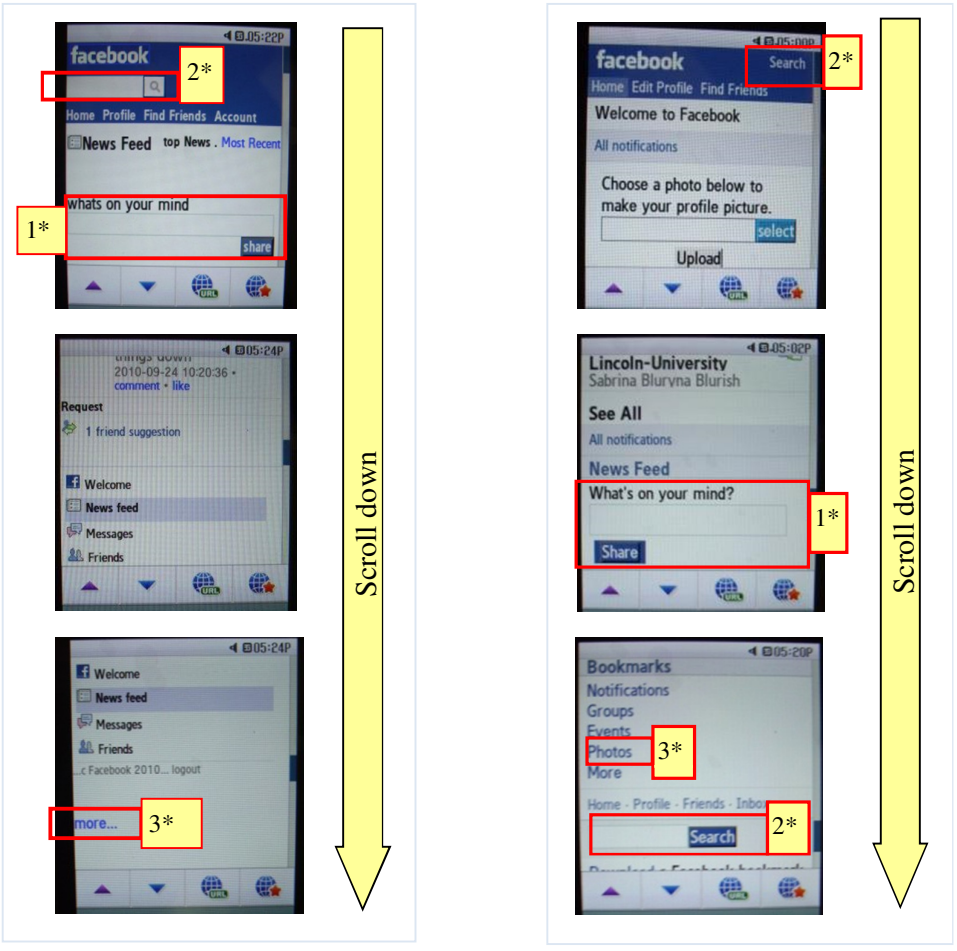
a) The mock version's Home page for Cik Cuba

b) The actual Facebook full site Home page for Cik Cuba

Figure 6.2 The Home page of the full mock version and the actual Facebook full site version for user Cik Cuba. The red rectangles highlight the locations of items needed to perform the tasks (yellow boxes with number indicate the task's number)

For study 1, to test our prioritisation concept we prioritised the mock Facebook pages (which will be referred to as the Prioritised version) and compared them to the actual Facebook mobile version. We created preferences (see section 5.4) for our user Cik Cuba.

The preferences were set up to meet our test criteria so that on the mobile device, the appearance of a few items was reordered or removed. For example, the update status box and the News Feed content were reordered to be located at the top of the page after the main menu. The left navigation menus were displayed after the News Feed and a few items and links were removed causing the 'more...' link added. Figure 6.3 illustrates the Home page of the Prioritised version and the actual Facebook mobile for user Cik Cuba, and the location of each task on both versions. The figure shows three screen shots of each version as participants scrolled down the pages on the mobile device. These pages were compared in Study 1.



a) The Prioritised version Home page for Cik Cuba

b) The actual Facebook mobile Home page for Cik Cuba

Figure 6.3 The Home page of the Prioritised version and the actual Facebook mobile version for Cik Cuba. The red rectangles highlight the locations of items to perform the tasks (yellow boxes with number indicate the task's number)

User Test Questions

After performing the three tasks on one version, participants were given four questions:

1. What are the things about the site that you liked?
2. What are the things about the site that you did not like?
3. Was any task difficult to complete? If so, please specify and explain.
4. Please provide any other comments about the site.

These questions were repeated after each version. The aims of these questions were to gather participants' opinion and evaluate participants' user experience on the versions investigated.

6.3.4 Post Test Survey

After participants completed the set of tasks on our mock page (full or prioritised) compared with the actual Facebook page (full or mobile), a post test survey was conducted. The goal of this session was to determine participants' preferred version of the page and their reasoning. We were also interested to see if there was any agreement among participants for the number of items that would be useful on a prioritised page. If so, this could form the basis for a default page.

First, participants were asked to answer three post test questions:

1. Which version of the site do you prefer?
2. What are the factors that influenced your choice?
3. If you could determine which items are displayed in the prioritised web, how many items would you like to display on your mobile?

Then, a semi-structured interview was conducted. Participants were asked questions related to their opinion about the overall concept of prioritisation. We asked open-ended questions about:

- removing less important items i.e. the 'more...' link to revealed removed items
- reordering the locations of the items, in which the most important item appears first

Finally, participants were asked to summarise what they thought about the two versions of the web pages they trialled. The interview was aimed to get more in-depth opinions about the concept of prioritising items on a website.

6.3.5 Pilot Study

The objectives for the pilot study were to validate research procedures and collect feedback of the trial materials. It was done to check whether the instructions were understood as we intended; to estimate the time required to complete the trial; and to test whether we were getting the detail of answer we expected. In short, it is to test the viability of the trial plan and to identify any potential problems before the actual trials (Preece et al., 2002).

First, all the questionnaire, tasks, and survey questions were tested for general correctness (Kerlinger & Lee, 2000). This was done in order to identify errors in the questionnaire, tasks, and survey questions in terms of wordings, ordering, layout, and instruction. In addition, the test was carried out to identify potential problems and to get an indication of the length of time required to answer the questions.

After the general correctness test of the questionnaire, tasks, and survey, a pilot trial was conducted on five participants who were Facebook users to see how the overall trial components (questionnaire, tasks, and survey) worked together. Four pilot trials were carried out for Study 1 using the touch screen phone (Samsung F480) and one using a 'keypad' phone (LG GM310) comparing the Prioritised version and the Facebook mobile version. The keypad phone was tested to see if it was helpful for a participant in terms of interaction with the device. However, the plan to use this mobile was discarded, as it was confusing for a participant to have to interact using both the keypad (for input) and the touch pad for navigation.

One pilot trial was carried out for Study 2 using a laptop comparing the full mock site and the Facebook full site.

The pilot for study on the mobile phone revealed that some users had real difficulties using an unfamiliar touch screen phone. Based on the feedback we decided to have a mix of touch-screen experienced and inexperienced participants and included questions about their familiarity with touch screen phones (see question 3 and 4 of Appendix F.1). The pilot trial for study 2 showed that the participant could easily use both full versions. The participant commented that the full mock version and the Facebook full site look similar.

6.4 Participant Recruitment

The population for the trials were Facebook users. To meet the objective of the trials, regular Facebook users were recruited as participants. Participants were recruited from the Lincoln University community. A few of the participants were personally approached and invited to

participate in the study; one was recruited through an in-class announcement; and the others were recruited through email broadcast. Participants were given a $10 voucher as a compensation for their time.

The number of participants required for a study depends on the objectives and type of the studies. Since our studies were mainly qualitative, recruitment of participants was stopped when we saw recurring patterns and data saturation after preliminary analysis. In total, 19 participants were recruited.

Fourteen participants were recruited for the mobile site trial (study 1). They were a mix of one staff member, one undergraduate student, and 12 postgraduate students.

Five participants were recruited for the full site trial on the laptop (study 2). One was a casual worker at the university, two undergraduate students, and two postgraduate students. These participants were not involved in study 1.

6.5 Venue, Apparatus, and Materials for the Trials

Audio recording and note taking were used in both studies to record data. Although it is not the main source for our data analysis, we also screen captured the participants' screens in study 2.

A test Facebook account (Cik Cuba) from our previous studies was used in these trials so that participants did not have to share their personal information, and to provide control and consistency for the studies.

The trials were conducted between 1st August and 8th October of 2010. The Facebook versions (the full site version and the mobile version) used for the trials were the versions available within that period. Since then, both versions have had a few changes and updates.

6.5.1 Venue for the Trials

In the natural environment, users may use Facebook in their free or leisure time, in between tasks and chores, and for lengths of a few minutes to several hours. However, to meet the purpose of the study and to have control over the participants and the situation, we conducted controlled experiments (Zhang & Adipat, 2005) in a quiet room free from distraction. We used controlled experiments in order to have full control over the experiment (Zhang & Adipat, 2005). The use of an audio recorder to capture data of participants' verbal reaction (Dumas & Redish, 1999) allowed us to validate our results (Lunn et al., 2008).

In addition, the room the trials were conducted was chosen due to the strength of mobile network and university wireless network signal it has. It was also to ensure that participants were tested under similar or equivalent conditions to ensure procedural fairness (see Section 6.10).

6.5.2 Apparatus and Materials for the Trials

In Study 1, we used the Prioritised version (see Section 6.3.3) and the actual Facebook mobile version as the trialled pages, and a Samsung F480 touch screen mobile phone (with Access browser and a proprietary OS) on a mobile network. Using real mobile devices will give us more realistic and reliable results than using emulators (Zhang & Adipat, 2005).

In Study 2, we used the full mock version (see Section 6.3.3) and the actual Facebook full site version; and a laptop (with Firefox browser and Windows XP OS) on the University wireless network.

6.6 Conducting the Trials – Data Collection

Unless otherwise mentioned, both studies followed the same test procedure and structure. Each study was designed to take around one hour. Each study was done with one participant at a time. The sessions were audio recorded. Each component of the trial was discussed in detail in Section 6.3. The Lincoln University's human ethics approval was first obtained for the studies. Study 1 was conducted and completed first.

Figure 6.4 illustrates the overview of the structure of the trials. The familiarisation with the mobile section is in a dashed-border box indicating that it was only applied in study 1.

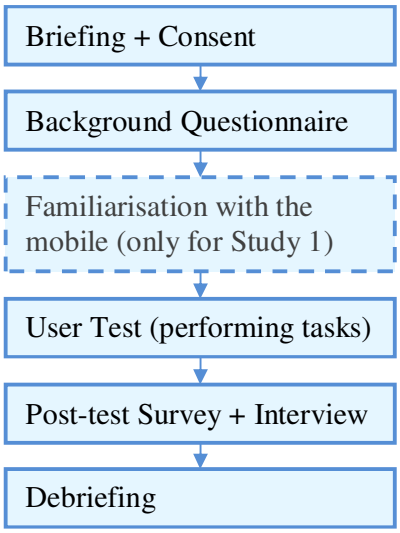


Figure 6.4 Structure of the Trial

The trials started with a briefing session. In this session, an information sheet explaining the trial was handed to participants. Participants were briefed about the studies and their consent to participate obtained.

Next, participants were asked to answer a background questionnaire. This was conducted in an informal manner where participants could ask for clarification of questions.

Then, in study 1, to mitigate the unfamiliarity with the mobile used, a session to familiarise participants with the mobile was conducted. This session was omitted in Study 2, trial on the laptop.

Next, participants were given an instruction sheet (see Appendix F.3) explaining the tasks. Participants were asked to perform a set of tasks (see Appendix F.3) using the think aloud protocol. Participants were observed and notes were taken during this session. In addition to this, participants' screens were also recorded in Study 2.

We used a within-subjects design for the trials. A within-subjects design method automatically controls for individual variability (Nielsen, 1993); all participants performed the tasks on both versions trialled. This would ensure that any factors that may affect participants' overall performance and preferences would be the same for both versions of pages trialled. To lessen the learning transfer effect, a counterbalancing approach (Sharp et al., 2006) was used. The orders of versions of pages participants trialled were alternated (see Section 6.7 and 6.8).

After participants completed the tasks for the two versions of pages trialled, a post-test study comprising a survey and a semi-structured interview was conducted.

Lastly, participants were debriefed about the study and thanked for their participation and a $10 voucher was given to compensate them for their time.

6.7 Study 1 – The Mobile Site Trial on the Mobile Phone

The purpose of this study was to investigate participants' user experience on the Prioritised version compared to the Facebook mobile version. This study was carried out on the mobile phone and it followed the structure discussed in Section 6.6.

As discussed earlier, we used a within-subjects design for the trials. The orders of versions of pages the participants trialled were alternated as shown in Table 6.2. Participants in group A used the Facebook mobile version first, while participants in group B used the Prioritised version first.

Table 6.2 The trial design for study 1

Group	First version trialled	Second version trialled
A	The Facebook mobile version	The Prioritised version
B	The Prioritised version	The Facebook mobile version

Data was analysed using both quantitative and qualitative approach. Data was recorded and transcribed after each trial and preliminary analysis was done. Results of this study are discussed in Section 7.2.

6.8 Study 2 – The Full Site Trial on the Laptop

The aim of study 2 was to demonstrate that participants could use the full mock up site as easily as the Facebook full site version. This study was carried out on a laptop.

As in study 1, Study 2 used the within-subjects design and followed the structure discussed in Section 6.6 except that the familiarisation with the mobile phase was not required. The orders of versions of pages the participants trialled were alternated as shown in Table 6.3.

Table 6.3 The trial design for Study 2

Group	First version trialled	Second version trialled
A	The full mock version	The Facebook full site version
B	The Facebook full site version	The full mock version

Data was analysed using both quantitative and qualitative approach. Data was recorded and transcribed after each trial and preliminary analysis was done. Results of this study are discussed in Section 7.3.

6.9 Measurements and Data Analysis

Data was objectively and subjectively analysed. For objective data, we analysed participants' responses from the background questionnaire.

During one of the sessions, the trial had to be ended because the second site to trial - the Facebook mobile site was down (under maintenance) for more than 20 minutes. This participant's response was discarded and was not analysed. We will only report on results from 13 participants for study 1 on the mobile phones.

A few usability and user experience attributes and measurement discussed in Section 2.2 were considered in these trials such as the efficiency and learnability (time taken to complete tasks); user experience or attitude in terms of satisfaction (liked and disliked); and ease of navigation (from time taken and participants comments, and observation).

These attributes were measured to help us to answer our research question discussed in Section 6.1.

Number of Completed Tasks and the Task Completion Time

We measured the task performance by measuring the number of successfully completed tasks and the time to complete each task. Measuring the time to complete the tasks, and number of successfully completed tasks provides an objective measure of whether the mock versions (full or prioritised) offer similar or better usability (experience and ease of use) as compared to the standard Facebook versions (full or mobile).

The audio transcript was used to calculate the task completion time. The start point being the time participants indicated that they were starting (ready to begin) the task. The completion time being the time participants found the correct item and/or when they indicated that they completed the task. The tasks were considered successfully completed when participants found the correct items.

For an incomplete task, we used the time at which participants ended (or gave up) the task; this approach is also used by Lunn et al. (2008). However, this approach may introduce bias to the results; the time participants gave up may skew the results. If there were participants who gave up on a difficult task 'too early', we would get faster/smaller mean completion time, but this would not reflect that the task is easy.

In order to minimise the bias and ensure validity of the result, for any task that was unsuccessfully completed by at least one participant, we also analysed only the mean time of successfully completed task and compared it with the mean completion time that includes the time participants gave up.

Theme and Preferences from Users' Responses

For qualitative and subjective data, we used participants' written responses from the survey and the audio transcript for their interview and analysed for recurring patterns or themes. This was done using thematic analysis. It "is a method for identifying, analysing and reporting patterns (themes) within data" (Braun & Clarke, 2006).

6.10 Threats to Validity

Procedural fairness is a crucial requirement for validity in testing (Kane, 2010). We have taken careful consideration to ensure the procedural fairness of our trials. Participants were treated the same way, performed the same tasks, under equivalent conditions, and their performance and response were evaluated using the same rules.

There are several types of threats to validity. Parker (1993) describes four types of research validity: internal validity, external validity, statistical conclusion validity, and construct validity. The most important is internal validity.

To ensure that we overcame and minimised possible threats, we identified the possible threats and ways to addressed them. The following are the potential threats in our studies and the discussion on how we addressed them:

- **Testing validity**

  The within-subjects design may cause potential learning transfer bias. To address this threat, the orders of versions trialled were counterbalanced; we alternated the order of versions the participant trialled (see Section 6.7 and 6.8).

- **Task validity**

  Task validity refers to the tasks being realistic and representing the real tasks users perform. To ensure the validity of the tasks, we have chosen the tasks from the most frequent tasks people performed found in our previous survey (see Section 6.3.3).

- **The validity and reliability of the measured task completion time**

  The strength and availability of mobile (or network) connection and participants' inexperience with the mobile used could be possible threat to the validity of the time taken in measuring the completion time. To address these threats we used two approaches. First, we conducted the trial in a room with strong wireless connection. When there were still losses of connection, we deducted the time during the loss from the total time taken to complete the task; the completion time will be measured as *total time – loss time*. As discussed in Section 6.9, this was done using the transcription record. Second, we conducted a familiarisation with the mobile session as discussed in Section 6.3.2.

- **Ecological validity**

  One case that a threat to ecological validity occurs is when participants are aware of being studied. Although it is difficult to eliminate this threat, participants were reminded that the trials were not testing their ability or capability, but were comparing the versions trialled.

  Another situation is when conducting a lab experiment as opposed to a field study, whether the results could be generalised as if the studies were done using field study approach where the location and procedures represent the real world case. However, as we were only testing the interface and not the context of use, using a lab experiment is considered appropriate (Zhang & Adipat, 2005). In addition, comparative studies of controlled experiment and field studies conducted by Kaikkonen et al (2005) found that the test location did not significantly affect speed and success of the task execution of the users and that there was no significant differences in the execution times of individual tasks between in-lab studies and field studies.

- **History**

  This threat may occur if some participants have already had experience with one of the versions of pages trialled causing invalid analysis and conclusion. To eliminate this threat, we only recruited regular Facebook users. In the case that some participants may have had experience with the Facebook mobile version, for analysis on the task completion time, we also analysed the completion time for only those with Facebook mobile experience separately. Threat can also occur if participants have had experience using a touch phone. To address this, we conducted a familiarisation with the mobile session as discussed in Section 6.3.2.

6.11 Summary

This chapter discussed the method and design of the user trials conducted to evaluate the usability and user experience of adaptive pages developed for the desktop but prioritised for the mobile devices by the prioritisation engine. We compared the full mock up and prioritised mock up pages versions with the actual Facebook full site and Facebook mobile versions. The next chapters will discuss the results of the trials and the evaluation performed to investigate the performance of the prioritisation engine.

Chapter 7
User Trial Results

In the previous chapter, we discussed the design of user trials to investigate the usability and user experience of the web pages produced by the Prioritisation engine. The trials compared pages developed for desktops and prioritised for mobile devices to Facebook pages developed independently for desktops and mobile devices.

This chapter presents the results of the trials. First, we outline an overview of the trials in Section 7.1. Then, we outline the results of studies conducted on the mobile phone (Section 7.2); conducted on a laptop (Section 7.3); and participants' overall opinion on prioritisation (Section 7.4). Finally, Section 7.5 summarises this chapter.

7.1 Overview of the Trials

As described in Chapter 6, we carried out user trials to investigate whether our prioritised version could provide a better or similar user experience when compared to the actual Facebook sites developed independently for desktops and mobile devices. In addition, we were interested in the aspects that participants liked and disliked about each version trialled. We also asked participants about their overall preferred version and their reason for this choice and for their overall opinion about prioritising items on a page. Two studies were conducted: Study 1 was conducted on a mobile phone comparing our prioritised mock up version to the Facebook mobile version and study 2 was done on a laptop comparing the mocked up full site version to the Facebook full site version. Appendix G provides the data and analysis for the results.

7.2 Study 1 – the Mobile Site Trial

The aim of the mobile site trial, as discussed in Section 6.7, was to investigate participants' user experience on the Prioritised version and the Facebook mobile version available at the time. The trials were carried out using a touch screen mobile phone.

At first, during the familiarisation with the mobile phase, participants' inexperience with the mobile phone caused them difficulties in interacting with the test pages and completing the tasks. Eventually, participants were successful in completing the tasks. One observation was reluctance for participants to scroll and they had to be encouraged to do so. Participants

understood that clicking the 'more...' link would provide them with more information. Realizing that it was not the actual "test", a few participants did not want to explore at length after completing the three tasks; they believed they were already comfortable with the phones. Participants were excited to move on to the next phase and do the actual test. We were confident they understood the layout of the pages.

7.2.1 Demographic Information

There were 13 participants (10 female, 3 male) aged over 16 (see Section 6.9). Six of the 13 participants had previously used touch screen mobile phones. Of the 13 participants, two claimed they were very confident with touch screen phones and five rated themselves as confident, four undecided, and two not very confident. One participant, having no experience with a touch screen mobile phone, rated herself as very confident may have had experience with other touch screen devices.

Only seven of the 13 participants access the web from their mobile with five of those seven participants also accessing Facebook from their mobile. All 13 participants access Facebook more than once a week on the computer with nine accessing it more than once a day.

7.2.2 User Tasks

As described in Section 6.3.3, we gave the participants three tasks:

- Task 1 – Update status
- Task 2 – Find friend
- Task 3 – Show photo album

The tasks were designed to investigate whether participants could locate and perform the commonly used tasks on the Prioritised version and the Facebook mobile version. We also wanted to determine whether participants could understand and find the removed low priority items; thus, the item for task 3 was initially removed although it is among the most frequent tasks people perform. We were interested in observing participant user experiences - whether the participants could perform the tasks and how would they perform the tasks – on the two versions.

Participants were not familiar with the mobile phone used in the trial. Participants' interaction with the mobile phone was slower on the first site they trialled, but was later improved as they moved to the second version trialled. As discussed in Section 6.6, we had a familiarization with the mobile session and, we had the partipants trialled the versions in a different order to

mitigate this problem. Group A trialled the Facebook mobile version first and group B trialled the Prioritised version first.

All tasks were attempted by all 13 participants. Generally, there was usually more than one path for users to find information or perform specific tasks. However, there was a little variation in participants' paths in completing the tasks. All participants successfully completed task 1 and 2 on the Prioritised version and the Facebook mobile version. However, one participant did not successfully complete task 3 on the Prioritised version and four gave up on the Facebook mobile version.

To show the relative location (similarities and dissimilarities) of each task on each mobile version (i.e. the prioritised version and the actual Facebook mobile version) to the actual Facebook full site, we will report (show) the interface of Facebook full site version first. Then, it will be followed by the results for the tested mobile versions.

7.2.3 Task 1 – Update Status

Task 1 (Update Status) was chosen because the feature to update status was visible and located near the top of the Prioritised version and the Facebook mobile version, and visible and located at the top of the actual Facebook full site version. All participants successfully completed task 1 on both versions.

Two places where users can update their status on the Facebook full site are on the Home page and the Profile page as illustrated in Figure 7.1.

Figure 7.1 Update status features on the Home page and the Profile page of the Facebook full site

Update Status on the Prioritised Version

Similarly, on the Prioritised version 12 participants updated their status on the Home page and one on the Profile page. Figure 7.2 illustrates the two locations where status could be updated on the Prioritised version.

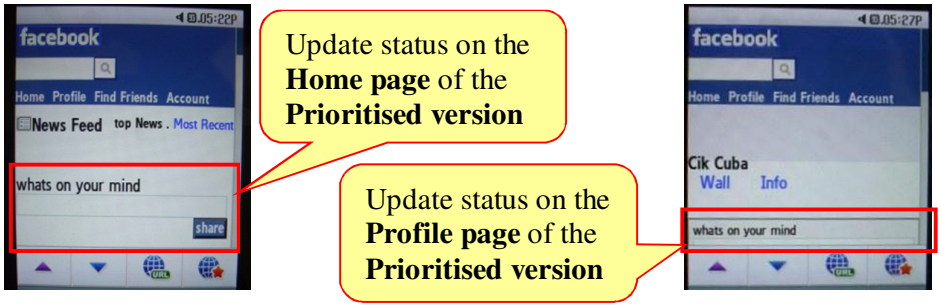


Figure 7.2 Update status box available on the Home and Profile page of the Prioritised version

Of the 12 participants who used the Home page, 11 updated their status on the Home page when they immediately spotted the update status box. However, the other participant overlooked the status box and had to click the link 'more...' first before realizing that the status box was actually at the top of the page.

In contrast, one participant went to the Profile page to perform the task as he claimed that was where and how he would normally do it when he used Facebook on his computer. However, once in the Profile page he was having difficulties. Although the status box was at the top on the Profile page (at the same location to the Facebook full site), he overlooked it and started to show his confusion by clicking other links available on the page. The participant claimed that he has forgotten where he could update his status. The participant finally updated his status using the status box after clicking the link Wall on the Profile page.

Update Status on the Facebook Mobile Version

On the Facebook mobile version, participants also updated their status on the Home page and the Profile page, in a similar way to the Facebook full site. Figure 7.3 illustrates the update status features on the Facebook mobile Home page.

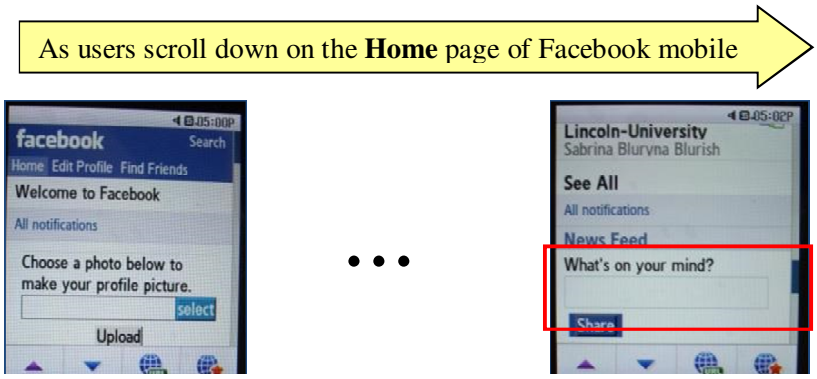


Figure 7.3 Update status box on the Facebook mobile Home page

Six participants chose to update their status on the Home page. However, most participants faced some difficulties in completing the task. Recalling that the status box was on the Home page of the Facebook full site, participants scrolled down the Home page to find the status box and four participants also, at first, overlooked the box while scrolling. For example, one participant, P1 commented, *"I scroll down but I couldn't find the... oh, it's very different than on the computer."* The participant was trying to use her experience with the Facebook full site while performing the task as she further added, "*I know where I'm going, I'm thinking of the big screen on the computer*".

The other seven participants attempted to update their status on the Edit Profile page. From observation, participants were actually looking for the Profile page (as it would be on the actual Facebook full site version), instead of the Edit Profile as one participant stated, *"I will go to Profile"* but clicked on the Edit Profile instead. This was because the link Edit Profile appeared on the top main menu where the link Profile is normally located on the Facebook full site. On the Facebook mobile, the link to Profile was located at the bottom of the page. Of the seven participants, six eventually went back to the Home page when they still could not find the status box after visiting a few links (such as wall, info, and Profile) from the Edit Profile page. One of the seven participants managed to update her status after she eventually found the link to Wall from the Edit Profile page. This confusion caused participants to take a longer time completing the task.

It was observed that, by having the status boxes and the link to Profile in locations close to where they are on the familiar Facebook full site, the item could be more easily found on the Prioritised version. In addition, having the items located at the top of the page where participants could immediately notice them, helped participants to quickly use the items.

However, having the items on the Facebook mobile in places which were different to the full site version caused more scrolling and clicking, caused a few participants to overlook them and contributed to participants' confusion. Performing task 1, as observed, was easy on both versions but was completed with less scrolling on the Prioritised version.

7.2.4 Task 2 – Find Friend

Task 2 (Find Amy) was designed to investigate whether participants could locate and use the search feature. The feature was located on the main menu on the header of the Prioritised version, at a similar location to the Facebook full site, but was located towards the bottom of the Facebook mobile version. As stated earlier, all participants successfully completed task 2 on both versions.

On the Facebook full site, one way to find whether a friend is on Facebook is by using the search box located on the main menus in the header of every Facebook page. The other option is to use the 'search for people' by name on the Find Friends page. Figure 7.4 illustrates the two features to find if a person is on Facebook if we only know the person's name.

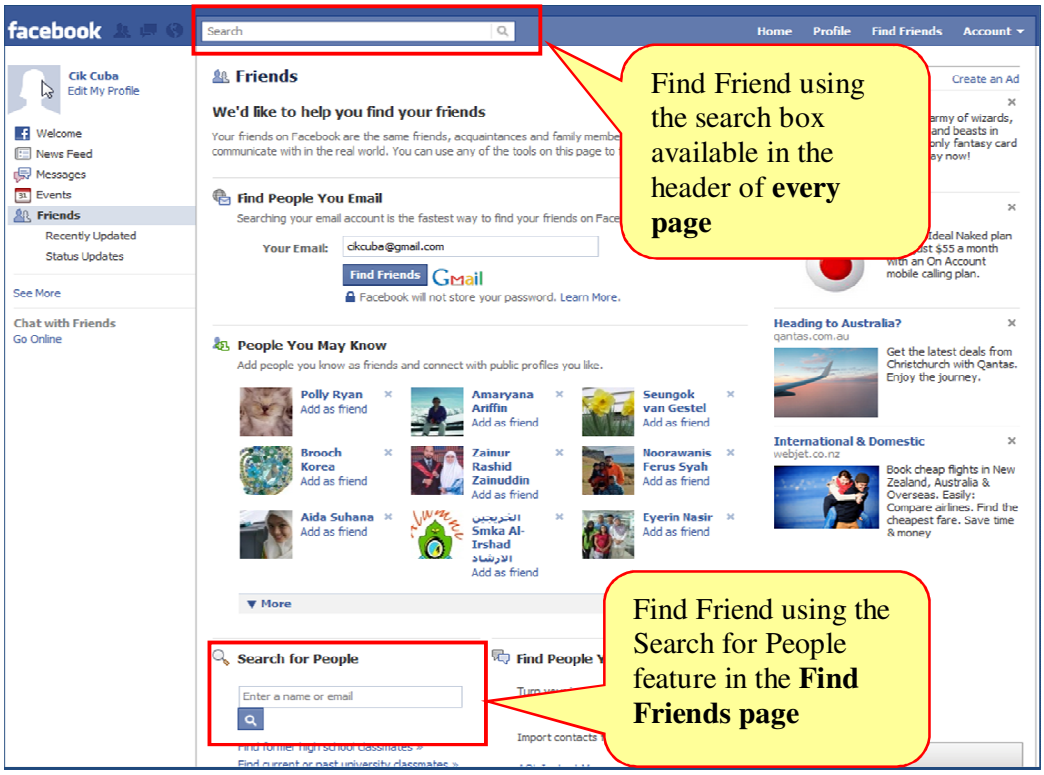


Figure 7.4 Features to find friends on the Facebook full site version

Find Friend on the Prioritised Version

On the Prioritised version, 12 participants performed the task without problems. Of the 12 participants, six immediately used the search box located on the main menu in the header of the Home page to look for Amy; five navigated to the Find Friends page first before using the search box located on the main menus in the header of the page. Also, one participant used the search box in the header of the Friends page.

One participant P14 however, was having problem with the task. She seemed confused and unsure of how to perform the task. Having navigated to and browsed the Find Friends page, the participant overlooked the search box at the top of the page and the feature to find friend by name in the content area. She moved from one link to another before ending up in the Friend page and used the Search for people feature. Figure 7.5 illustrates the location of find friends features on the Prioritised version.

Figure 7.5 Features to find friend on the Prioritised version

Find Friend on the Facebook Mobile Version

On the Facebook mobile site, most participants eventually used the Find Friends page. Ten participants navigated to the Find Friends page and used the search function there. Seven of the 10 participants used the search feature on the page; the other three had minor problems and showed their confusion by scrolling up and down the page, and trying a few other links before eventually using the search box on the page.

Two participants used the search feature on the Home page. One participant used the search feature on the Profile page.

Figure 7.6 illustrates the location of find friends features on the Facebook mobile version.

Figure 7.6 Features to find friend on the Facebook mobile site

It was observed that having the search box at the top of the page and similar to the Facebook full site assisted participants to quickly use the feature on the Prioritised version. Not having the search box at the top of the Facebook mobile site caused participants to click the Search link at the top of the page before being directed to the bottom of the page where the search box was located. A few participants also scrolled up and down to look for the search box and a few overlooked it initially.

7.2.5 Task 3 – Show Photo Album

Task 3 (show photo album), as stated earlier in Section 7.2.2, was designed to investigate the idea of hiding low priority items. The links to photo albums were initially removed in the Home page and Profile page of the Prioritised version; visible on the bottom group of links towards the end of the Profile page and the Edit Profile page of the Facebook mobile version; and visible on the Facebook full site. Figure 7.7 illustrates the links to find photo albums on the Facebook full site version.

Figure 7.7 Links to Photo albums in the Facebook full site Home and Profile pages

Of the 13 participants, 12 successfully completed task 3 on the Prioritised version and nine on the Facebook mobile version.

Show Photo Album on the Prioritised Version

On the Prioritised version, 12 participants from the Home page directly navigated to the Profile page. Of the 12 participants, ten, recalling the locations of Photo links on the familiar Facebook full site, confidently clicked the 'more...' link when they could not find the links to Photo on their usual locations (at the top next to the *wall* and *info* tab, and in the navigation links at the bottom of the page) to reveal the links. One example of participant comment while performing the task was, "*it has wall and info, usually it will have photos here but it's not there so I just scroll down and try to find … and I click on more just hoping that I can find something there... ya, there is photos there [near the wall and info tab]*".

The other two of the 12 participants were having problems with task 3. Unable to find the links to Photo in the Profile page the participants trialled the Account page before eventually navigated back to the Home page. In the Home page, these participants repeatedly scrolled up and down before deciding to click on the 'more...' link. The participants were first confused

with the list of available sub-links under the Photo link. Participants hesitantly chose the My Upload link before confirming that they found their photo albums.

The participant who was unsuccessful in completing task 3 chose the Recent Albums link instead of the My Upload link. Probably because it is not her actual account, she was very determined that it was indeed her album.

Figure 7.8 illustrates the links to Photo albums on the Prioritised version Profile page and Home page.

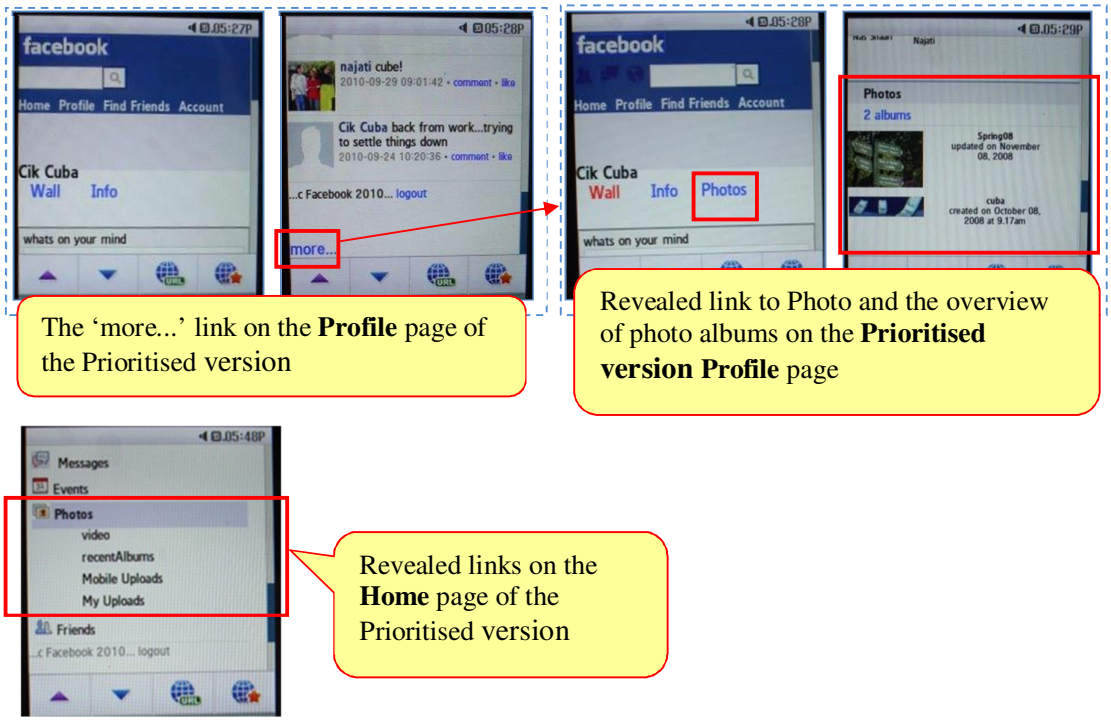


Figure 7.8 Links to Photo albums in the Prioritised version

Show Photo Album on the Facebook Mobile Version

On the Facebook mobile version, of the nine participants who successfully completed task 3, three chose the link to Photo albums at the bottom of Edit Profile page and two chose the link in the Profile page. The other four participants were having a few problems in finding the photo albums. Participants were expecting to get the photo albums or photos if they clicked the Photo link in the group of bookmark links towards the bottom of the page. Participants were frustrated that the link directed them to the Photo Stories page, a new page they have not experienced on the Facebook full site. Participants seemed confused that the link did not

function as what they expected. Participants then, simply and repeatedly trialled other links such as Photo Stories, Photos, Most Recent, and Edit Profile before they eventually found the right link to photo albums. Figure 7.9 illustrates the links to Photo albums on the Edit Profile page and Profile page of the Facebook mobile version.

Figure 7.9 Links to Photo albums in the Facebook mobile version

Four participants could not complete task 3 on the Facebook mobile because they could not find the links to Photo albums. One participant, P3 commented, "*because that's the only thing that I can find here View photos of me, because usually, on the desktop, I can find it easily. I've already tried and it should be somewhere up here and I can't find it.*"

Having items described with similar terms and in familiar locations to those used on the Facebook full site, made performing tasks simpler and easier (less clicking and scrolling) on the Prioritised version. Conversely, new links and pages, which were dissimilar to the Facebook full site confused participants on the Facebook mobile site.

7.2.6 General Observations

Throughout the trials, participants were observed trying to use their experience and knowledge from the Facebook full site to carry out the tasks on both the prioritised and actual mobile versions. Participants seemed to easily find, with less clicking and scrolling, the items they were looking for if the order or locations of items had some similarities to the Facebook full site version. Conversely, most participants were inclined to overlook the items that they were looking for if the items appeared in a different location to that on the Facebook full site version.

It was observed that participants, using their desktop experience, have already determined where things should be on a page. Thus, not initially finding the items where they expected them to be, a few participants were reluctant to scroll further or carefully inspect the page. This reluctance to scroll caused the participants to try and click any link available on the top of the page even though the links were incorrect. This observation is similar to those of (Marsden et al., 2002; Shrestha, 2007) who found that participants are reluctant and not prepared to scroll.

7.2.7 Tasks Completion Time

The aim of the trial was to compare how participants performed a set of tasks on the Prioritised version and on the Facebook mobile version. The way participants performed the tasks and the path taken could affect the time to complete the tasks. Task completion time could also suggest the ease of use and the ease of navigation of a particular site.

Realizing that participants may still have difficulties with the touch screen phones and that the completion time was not the main factor studied; we did not limit the time to complete each task. From our observations, most participants were determined to complete the tasks.

The time taken and measured in this section may not be accurate due to the loss of connection during the trials or participants' inexperience with the mobile phone used. Although there were only two occurrences, these factors may introduce threat to validity as discussed in Section 6.10.

As described in Section 6.9, when there was an incomplete task, the time participants ended the task was used as the completion time. This method, however, may introduce issue with the validity of the measured time as the longer or shorter time participants took before giving up will skew the time. To overcome this issue, where there was any incomplete task (participant gave up or unsuccessfully completed the task), we also analysed the completion time for only the successfully completed task (see Section 6.10).

On average, participants completed tasks faster on the Prioritised version than on the Facebook mobile version. Figure 7.10 illustrates the mean task completion times of 13 participants for the Prioritised version and the Facebook mobile version.

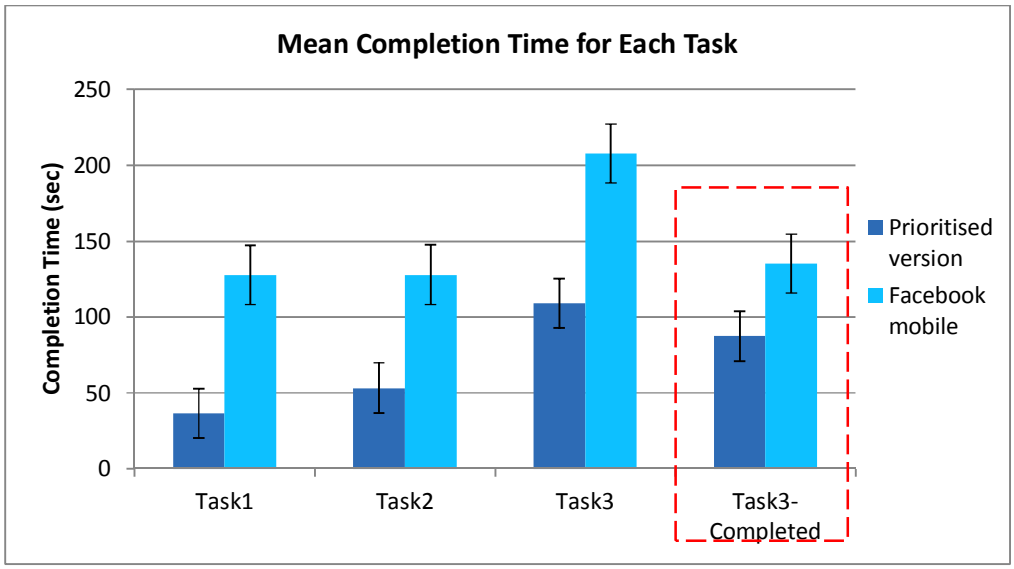


Figure 7.10 The mean tasks completion time for the Prioritised version and the Facebook mobile version.

Results suggest that the Prioritised version is easier to use and that common or frequent tasks could be completed faster. Results showed that, although the overall layout of the Prioritised version is different than that of the Facebook full site, having the most common items at the top of the page and similar to the Facebook full site helped users find the items faster. In contrast, the more unfamiliar Facebook mobile confused participants and resulted in more time spent locating items.

Completion time for Task 3 (showing photo albums) was the longest for both versions trialled regardless of whether the time participants gave up the task was included or excluded from the result, but probably due to different reasons. On the prioritised version, the links to photo albums were initially removed. On the Facebook mobile, the links were visible but were hard to find due to their location. Although the link 'more...' was a new concept for the participants, they were still able to find items via the 'more...' link more quickly than on the actual Facebook mobile site.

A paired-samples t-test was conducted to examine whether there were significant differences of mean completion time between the tasks performed on the Prioritised version and the tasks performed on the Facebook mobile version. The t-test results revealed completion time for each task was significantly shorter ($p < 0.05$) on the Prioritised version than on the Facebook mobile version as shown in Table 7.1.

Table 7.1 The paired-samples t-test results

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PrioritisedTask1 - FBmobileTask1	-91.23077	148.78181	41.26465	-181.13871	-1.32282	-2.211	12	.047
Pair 2	PrioritisedTask2 - FBmobileTask2	-74.53846	83.53005	23.16707	-125.01517	-24.06176	-3.217	12	.007
Pair 3	PrioritisedTask3 - FBmobileTask3	-98.84615	143.68301	39.85050	-185.67293	-12.01938	-2.480	12	.029

The high standard deviations suggest the data distribution deviates from a normal distribution. The high standard error means there are high variation between participants' completion time. This is caused by the longer time taken by a few participants to complete or to give up on a task. In order to confirm the result, we also run a non-parametric Wilcoxon test. Results confirmed those of the t-test. On average, each task was completed faster on the Prioritised version than on the Facebook mobile version - tasks 1 (p=.043), task 2 (p= 0.007), and task 3 (p =.007).

As stated in Section 7.2.1, five participants accessed Facebook from their mobile. Figure 7.11 illustrates the mean time taken to complete each task on both the Prioritised version and the Facebook mobile version for those five participants; the task3-completed columns show the mean time for only the successfully completed Task3.

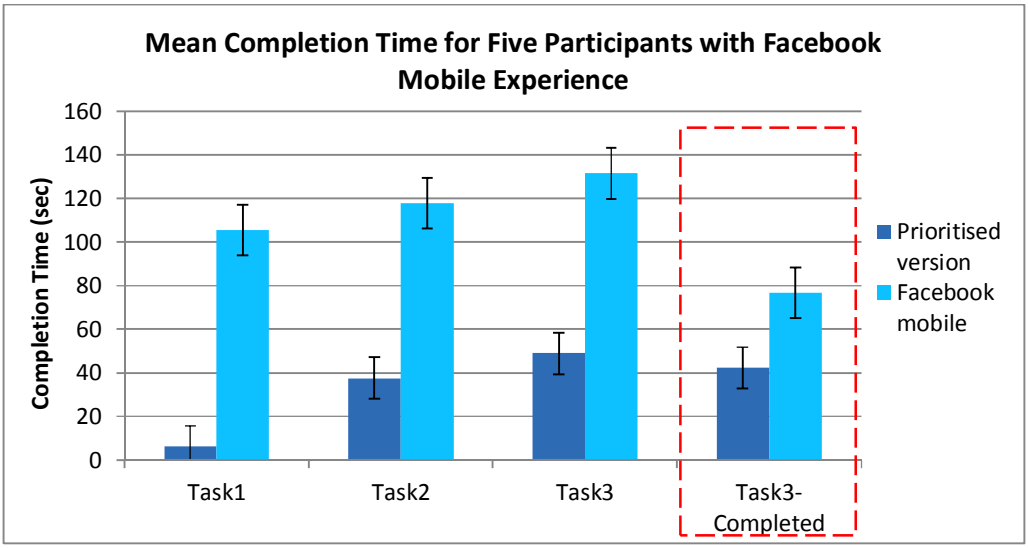


Figure 7.11 The mean task completion time for the five participants who have been accessing Facebook on their mobile. Error bars show the standard error.

These results showed that participants performed faster on the Prioritised version although they have experience with the Facebook mobile version. The results indicate that, it was

helpful that the Prioritised version was similar to the Facebook full site even for users with experience of the mobile site. We found this result particularly encouraging.

As described earlier, in order to avoid the bias of order effect, the order of the versions trialled was alternated. We had half of the participants (group A) trialling the Facebook mobile version first and the other half (group B) the Prioritised version first. The result of each group's completion time for each task is illustrated in Figure 7.12.

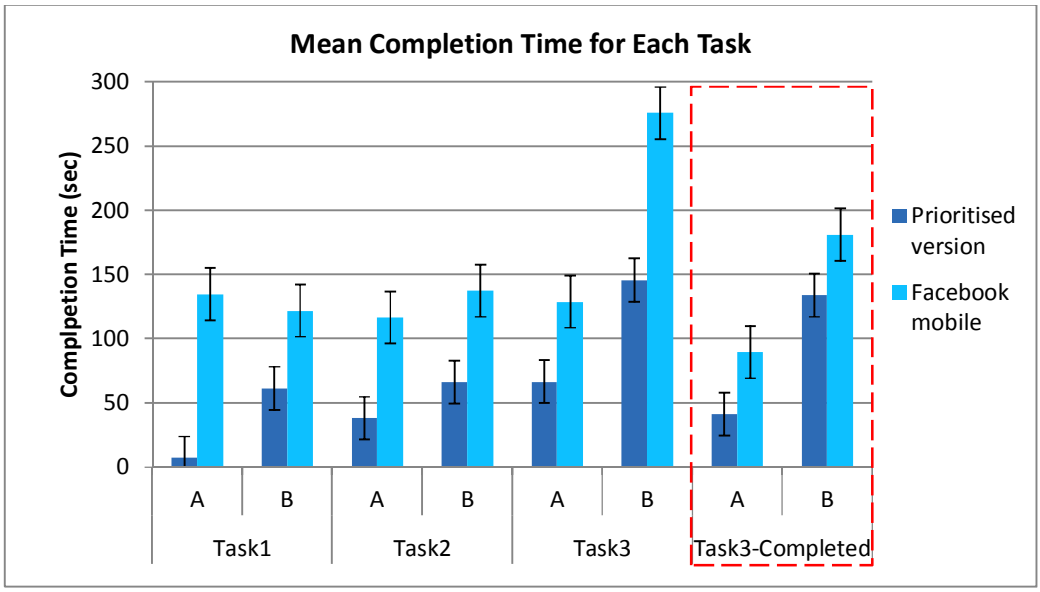


Figure 7.12 The mean time taken to complete each task for each group. A trialled the Facebook mobile first, and B trialled the Prioritised version first.

Results showed that participants completed the tasks more quickly on the Prioritised version than on the Facebook mobile regardless of the order the version was trialled. The mean times for the Prioritised version in Group A (the Prioritised version was trialled second) were less than in Group B (the Prioritised version was trialled first). This was due to a few individual participants who had forgotten how to update status (for task1) and were confused and having problems with tasks (task 2 and 3) as discussed in the previous section. Excluding the outliers gave a similar mean completion time for group A and B.

A few biases were observed on the completion time, for example, for task 3 for group B. The high mean times were due to a small group of individuals who were having problems with the task as described in the previous section. Also, it was caused by the longer time taken by participants who gave up the task for the Facebook mobile version or unsuccessfully completed it on the Prioritised version. Excluding the time taken for the incomplete or unsuccessfully completed task 3 as illustrated by task3-completed showed the difference.

The time taken to complete each task suggests that although participants are new to the Prioritised version, they learnt to use it easily, and performed the tasks more quickly than on the Facebook mobile version.

The participants' comments indicate that the similarity to the familiar Facebook full site allowed them to apply their knowledge and experience to make sense of the version and tasks.

7.2.8 Overall Preference and User Opinion for Study 1

After performing the tasks on each version trialled, participants were asked to answer questions related to what they liked and disliked; whether they found any task difficult; and any general comments they have about the version. Later, after completing the tasks on both versions, participants were asked to choose their preferred version and their reasoning; and their opinion on prioritisation.

As discussed in Section 7.2.2, most participants were not familiar with the mobile phone used in the trial, consequently, a few (3 participants) commented that their inexperience with the mobile had influenced their performance of doing the tasks on the first version they trialled. Two participants also did not like the small interface of the versions due to the mobile's small screen.

User Opinion and Discussion on the Prioritised Version

The Prioritised version was prioritised and adapted from the mock Facebook that resembled the actual Facebook full site at the time. We were hoping to offer a sense of familiarity to participants through similarities with the actual Facebook full site.

The majority of participants (12 out of 13) preferred the Prioritised version to the Facebook mobile version. Clearly, the order in which the version was trialled first did not affect participants' preferences. The other participant, liked the location of items/tasks (especially the status box) on the Prioritised version, but preferred the look and layout of the Facebook mobile version.

In the following sections are some of the comments grouped under recurring themes.

Similarities to the Facebook full site (desktop version)

Participants' comments showed that they believed the Prioritised version was similar to the Facebook full site that they were familiar with. The sense of familiarity made it easier for the participants to use the Prioritised and was one of the main reasons given for participants preferring this version. The following illustrate participants' comments. P1 commented, "*It*

displays the figures [icons] I'm related with when I'm in the computer". P4 commented, *"I mean like for me I'm used to use the one on the PC or desktop, so when I use the one, the same outline, the page is the same like the PC, then it's ok for me cause I'm familiar with it."* P8 said, "*easy to browse [...] not so much different with the one I experienced on the laptop*". Similarly, P12 commented "*it is almost similar to desktop version*" and P14 explained, "*I can use my basic knowledge learned from using Facebook on the computer to navigate around in this version*".

Easy to use/User friendly layout and order of items

Participants who did not specifically say that the Prioritised version was similar to the Facebook full site, commented that the layout and the order of items was user friendly. This might be because items were in similar places to the Facebook full site version they were familiar with.

Four participants thought the layout and order of items on the Prioritised version made finding information or links easier and reduced scrolling within the page. For instance, P2 commented "*order [i.e] layout of the screen is more friendly*". Likewise, P11 commented "*much more user friendly. I can find the menu/link easily, no need to scroll up & down looking for the menu*" and further added "*easy to find and spot the menu and the way, what we call this, the way... the order of the items and also the layout is convenient for us to operate… user friendly is the conclusion*".

Generally, the layout and the way items are ordered on a page would also affect navigation within the page. Three participants declared that the Prioritised version's layout and the order of items made navigation within the page easy. P3 commented "*I find it easier to navigate*" and when asked to explain more, added "*somehow I find it familiar to me*". P7 said "*easier to navigate coz of the layout; less info on the screen*". Similarly, P10 commented "*easy to navigate, more feature...*"

In addition, one participant thought the Prioritised version was user friendly and somewhat guided her. The participant, P5, commented "*the second one [the Prioritised version] is easier... like... it guides you*" and also remarked "*much more easy to use [because it is] simple [and I was] able to navigate; I don't have to think too much*". Another participant p13 liked that the Prioritised version was "*more clear what to click, to access*".

Participants' comments about the ease of use of the Prioritised version justify the number of completed tasks and the completion time for each task as discussed in Section 7.2.2. As the

Prioritised version was easy to use, participants completed the tasks faster on this version than on the Facebook mobile version.

While not all participants mentioned the similarity with the Facebook full site version, we suspect much of the perceived ease of use was because they found items where they were used to locating them.

Problems caused by removed (hidden) links

One way the Prioritised version differs from the Facebook full site is that some links and items were "hidden" under the 'more...' link. A few participants found the removing of certain links caused difficulties. As described in Section 6.3.3, we purposely removed the links to photo albums to test the removing of low priority items in the Prioritised version. Five participants believed removed links caused confusion because they had to do more clicking and scrolling.

Four participants found task 3 (show photo albums) difficult because the links to them were initially removed. Of the four participants, two disliked that they had to click the 'more...' link. For instance, P5 found task 3 difficult only because the link to photo was initially removed and complained "*button more, so I have to click it to expand the page*". Similarly, P12 who also found task 3 difficult commented "*Finding the photo album was confusing. We have to click more to link to the photo page*". The other two participants disliked the removing of links to photos because they had to do more scrolling. This was probably because the 'more...' link was at the bottom of the page; participants had to scroll further, or up and down to find the link. Participants might overlook the 'more...' link or might initially forget that it would reveal removed links. For example, P7 who disliked scrolling gave the following remark about the difficult task "*looking for photo albums because I need to scroll*". Similarly, P9 found task 3 as confusing because of the scrolling and commented, "*Task3. So confused. Scroll down or up to get what I want finally*".

One participant disliked that certain links were removed in the Prioritised version, although did not find any task difficult. P2 commented "*not all the links are shown in the screen (at least the more important)*".

While there was some confusion about the 'more...' link we have to remember that the users had not experienced this on the Facebook sites they were using. Participants generally expressed their agreement that unimportant links or links that are rarely used should be

removed so they could have an uncrowded page. This will be further discussed in Section 7.4.2.

Problems with single column layout and reordering of items

The Prioritised version was displayed in a single column layout in the mobile phone. The location of columns and items were reordered according to their ranks specifically chosen for the trials (See Section 6.3.3). The presentation and the ordering could have been done differently with different ranks.

Two participants expressed a problem with the order and location of links on the Prioritised version. One participant P6 disliked that the links, such as the *Photo* links, were at the bottom of the page and commented, "*links on the bottom such as photos*" and further commented, "*if the link are going to be visited, then put them on top*".

The other participant P13 also expressed her dislike in which she commented, "*The extra navigation links [navigation links on the left column in the Facebook full site] should be at the top. Messages link should be at the top".*

Clearly, these are views determined by the participants' usage of particular features. The problems expressed may be mitigated by allowing the users to choose their own order for the items on a page as our prioritisation engine allows.

P2 who thought there were some similarities between the Prioritised version and the Facebook full site, however commented "... *there are many links in different position compared to the computer's screen*". This was probably because the group of links, which was on the first column on the Facebook full site, was located at the bottom of the page.

Once again, this issue can be resolved by allowing the user to determine the order, which suits them.

Summary for the Prioritised version

Results showed that there were no significant problems with completing task 1 and 2 on the Prioritised version. Only a minor problem was found in task 3 – participants had to scroll down and click the 'more...' link in order to show the links to photo albums. This was also noticed in Section 7.2.2, which explained why the time taken to complete task 3 on the Prioritised version was the highest among the three tasks performed on this version.

Our anticipation that the similarity to the Facebook full site could help participants in using the site was met. Participants performed better in familiar pages. And, as observed in the trial

phase, participants were trying to use their experiences with the actual Facebook full site version while performing the tasks. For these reasons, consistency with the desktop is important.

User Opinion on the Facebook Mobile Site

The Facebook mobile site is a single column site developed independently for mobile devices. In the site, there are two main groups of menus, located at the very top of the page (in the header) and towards the end of the page. The content for a particular page is located between these two groups of menus.

As seen in the Prioritised version section, participants were trying to use their experience with the Facebook full site to interpret and carry out tasks on the Facebook mobile. The majority of participants had some issues with Facebook mobile.

In the following sections we summarise some of the recurring themes.

Dissimilarity to the Facebook full site

Four participants commented that they were not familiar with the Facebook mobile site. For example, P1 commented: "*I'm not familiar with the positions of the items of Facebook in the phone, so it was difficult to look for the information that I want*". Similarly, P7 commented, "*got confused with the layout of the screen because I have to get familiar with the layout on the mobile screen, lots of scrolling*".

Problems with items not in the expected places

In general, participants commented that the items on the Facebook mobile site were not in their usual places. Extra items, which are not available on the Facebook full site have been added to the Home page causing two participants to believe that they were not getting what they expected to get on the Facebook mobile site. For instance, P2 commented about the location of the status box not being displayed at the top of the page and remarked, "*in the top of the screen [on the Home page] is the option about how to search friends instead of look... your status or friend status*".

The Facebook mobile site has different links on the Home page and some of the links that are the same as the full site version were in different locations where participants did not expect them to be. This issue caused a few participants to mistake links with similar names but different functionality for another link. For instance, P3 commented, "*the item used for the menu is quite confusing, e.g. Edit Profile/Profile*" and further elaborated, "*because the first*

one is Edit Profile, Home and Edit Profile. I think if they put it Profile may be it would be less confusing for me". Additionally, three participants also thought specific links such as links to Profile and Photo albums were missing. For instance, P13 commented that she could not find the link to photo albums "*I can't find it anywhere I go*". These confusions had caused participants problems in finding the right link; participants commented that they had to do more scrolling and clicking to get to the items they were looking for.

Links not functioning as expected

The Facebook mobile site Home page has a link to a Photo Stories page; this link is not available on the Facebook full site. Three participants thought this link did not function as expected. This was because, when participants clicked the Photos link at the bottom of the Facebook mobile site Home page, participants were directed to another page Photo Stories, but found no photos displayed as expected. Clicking the Photo Stories link in the Photo Stories page, gave participants the same page. This situation confused and frustrated participants. For instance, one participant P12 commented "*hmm how do you say that, because there was like so many links to photo but you don't end up at photo albums... too many to photos... ya, I was finding... like there was photos but it ended up at photo stories and then ya, 'upload photos' but it didn't show like photo albums..so...*". Figure 7.13 illustrate the link to Photo and Photo Stories that led participants to the same page.

Figure 7.13 Links to Photo and Photo Stories that were found to be confusing

Participants' comments on the confusions and difficulties with the Facebook mobile site justify the smaller number of participants who completed task 3 (show photo albums) and the longer time taken to complete all three tasks on the Facebook mobile described in Section 7.2.2.

Other Comments

Only one of the 13 participants preferred the Facebook mobile version over the Prioritised version. P8 preferred the Facebook mobile version due to its design and commented "*but, I would prefer hmm... the web design of the second [i.e. the Facebook mobile], I prefer second's web design because you have your picture and you have your status next to it*". P8 also liked that the Facebook mobile was "*much more legible*".

In general, participants liked the design and appearance of the Facebook mobile site. One participant, P3, liked the simplicity of the Facebook mobile and thought it was less congested as compared to the Facebook full site in which she commented, "*not so much of pictures because at least when people just update their pictures or when they just talk about other people commenting on… is not viewed here*".

Summary for the Facebook mobile version

Three participants found task 1 difficult; two thought task 2 was also difficult; and eight out of 13 participants found task 3 difficult on the Facebook mobile site.

Generally, results showed that there were minor problems with completing all three tasks on the Facebook mobile site. Participants were confused with the location of items and links; and with the additional new/extra items, causing them more scrolling and clicking. This confusion and difficulties were discussed in detail in Section 7.2.2 .

7.3 Study 2 – the Full Site Trial (Desktop Comparison)

The aim of study 2 was to show that the mocked up full site was at least as 'easy to use' as the actual Facebook full site version. We wanted to make sure that the underlying changes to the page (to enable prioritisation) did not impact on the user experience of the full site. Our mocked up page will clearly be somewhat different to the actual Facebook page but this trial was to ensure there were no major problems with a page developed with prioritisable items.

7.3.1 Demographic Information

As described in Section 6.4, five people (four female, one male) aged above 16 participated in the study. It should be noted that these participants had not participated in Study 1 (mobile versions trials).

All five participants accessed Facebook more than once a day from the desktop and only one participant had accessed Facebook from a mobile device (less than once a week).

7.3.2 User Tasks Results for Study 2

Participants had to perform the same three tasks as in Study 1 - Update status; find Amy (friend); and show photo albums – on the mocked up full site and the Facebook full site on a laptop. As in study 1, the order of the versions trialled was also varied to reduce bias.

Generally, participants completed all tasks successfully on the mocked up full site and the Facebook full site. Most participants completed the tasks the same way on both versions resulting in similar number of clicks and completion time. Having completed the tasks on the first version trialled, the participants indicated that they would do the same thing on the second. For instance, P1 commented "*So, I'll still go to er... what's in your mind [the feature to update status]*". A few participants however, wanted to share another of their common ways of performing a task, showed and used different path to complete a particular task on the second version they trialled.

As most participants completed each task similarly on both versions, the time taken to complete each task was almost identical. Figure 7.14 illustrates the mean completion time for each task on both versions.

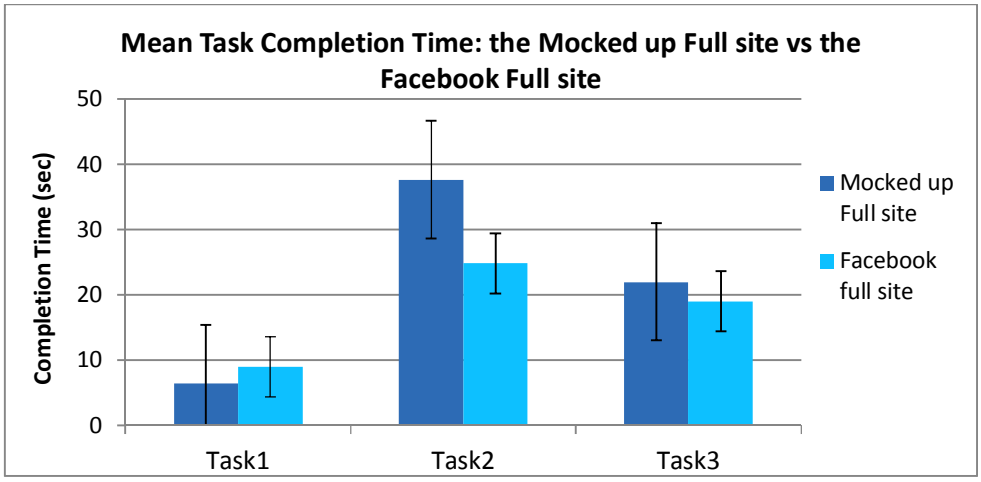


Figure 7.14 The mean task completion time for each task. Error bars show the standard error

The overlap standard error bars indicates that the difference between the two means for each task is not statistically significant. However, a few things affected the mean. For instance for

task 2, two participants took twice the time to complete the task on the mocked up full site version than the time they took on the Facebook full site version. One participant, P3 who trialled the mocked up full site version first was having difficulties to find Amy. P3 made up a scenario about Amy being a friend to a known friend before demonstrating the way she would normally find friends through the list of known friends or suggested friends. The other participant P4 who trialled the mocked up full site second, decided to show different ways of finding friends and commented *"sometimes I used to go from here [friends you may know] ... I'll go the same, like go to Friends, hmm I forgot, I used to use this"*. Excluding the time taken by P3 and P4 from task 2 resulted in a smaller difference in the completion times: 17 seconds for the mocked up full site version and 21 seconds for the Facebook full site version.

7.3.3 Overall Preference and User Opinion for Study 2

As in study 1, participants were given a set of questions related to each of the versions they had just trialled. Participants were surveyed about their preferred version and their reason for their preference, and interviewed about their view on prioritisation.

As observed earlier in Section 7.3.2, participants thought the two versions were similar. For instance, P3 commented: "*I honestly when I looked at the sites and performed all the three tasks, I don't think I saw any differences* [...] *no differences, I didn't even know there were two versions of Facebook*". As a result, participants generally gave the same comments for both versions. Comments were mostly their views about Facebook in general.

The only reason given which participants considered the mocked up full site version inferior to the Facebook full site version was its less colourful and attractive interface. Four of the five participants preferred the Facebook full site to the mocked up full site because it looked more lively and attractive, with more comments and colourful pictures. This comment was expected since the mocked up full site version was not as professional looking as the Facebook full site version. The visual difference was due to the Prioritised full site version being a mocked-up page with limited friends posting and pictures, while the real site for Cik Cuba has 'real' people as friends with frequent dynamic and real time updates.

7.4 User Opinion on Prioritising

Participants were also interviewed about their general views on prioritisation (see Section 6.6).

The majority of participants from both studies (16 of 18) liked the idea of prioritising web pages, particularly for their mobile devices. Most participants believed having four to five items on the mobile device is an appropriate number as more items would make the page crowded.

In depth questions were asked about the hiding of less important items and the reordering of items in new positions (see Appendix F.6). The results of these questions are discussed next.

7.4.1 Items to Prioritise (or to Display)

Our prioritisation system will be particularly valuable if developers can find default settings that would satisfy the majority of users. This would mean that most users would not need to create their own settings and this in turn would help with the performance of the engine (see Chapter 8).

In the background questionnaire, participants were asked about the importance of tasks on desktops and mobile devices. Results showed that participants thought all tasks are important on their desktop, but only a few are important on their mobile device (see Appendix G.3).

To determine possible sets of default for devices, we asked participants for the five most important tasks to perform on their desktop and mobile device. The task will get higher score if it was ranked higher by more participants (see Appendix G.3 for example of the calculation). Although participants' preferences differ, results showed a possible set of defaults for devices. Table 7.2 shows participants' choice of most important tasks for desktops and mobile. Results showed that the important tasks can be grouped into three tiers:

- Tier 1 - tasks with scores between 30 to 60 (four for both mobile desktop)
- Tier 2 - tasks with scores between 10 – 30
- Tier 3 - task with scores less than 10

Table 7.2 The importance of tasks on desktop and mobile device; the bold scores are those in the first tier

Tasks	Q11.The Five Most Important Task	
	Desktop	Mobile
A. View notification/updates	**46**	**41**
B. Update your status	15	15
C. Read comments on your status	**32**	**33**
D. Update/edit your profile	4	0
E. Read messages	**52**	**56**
F. Write/reply messages	**35**	**36**
G. Update/upload photos	16	4
H. View friends photos	9	3
I. Comments on friends photos	3	2
J. View videos	0	0
K. Update/upload videos	5	1
L. View friend page/profiles	2	5
M. Search/invite/add friends	2	3
N. View forum/discussion/group	10	9
0. Update/reply forums/discussions/group	4	1
P. Play games	5	9
Q. Play music/songs/playlist	4	17
R. Update/upload music/songs/playlist	1	10
S. Write comments	14	8
T. View posts on your wall	11	19

Having seen how the prioritised versions looked (during the trial), we asked the participants again, of the number of important items they wanted (thought important) to have on their mobile devices. Results showed an agreement between participants. Participants wanted to have five items on a page so that they could have uncrowded pages that would ease them in navigating and finding items of interest.

We also asked the participants to determine the items they wanted to have on their mobile devices.

Table 7.3 shows the number of times items were mentioned when participants were asked about items to prioritise on mobile devices.

Table 7.3 The number of times items to be displayed on mobile device were mentioned

No	Items	Count
1	Messages (read / write)	13
2	Status (update / comment)	7
3	Notifications	6
4	Friends (list / page / find friends)	6
5	Profile	5
6	Photos (view / upload)	4
7	Wall	3
8	News Feed	3
9	Search	2
10	Home	2
11	Friends' Request	2
12	Account	1

Results are consistent with those gathered from the background questionnaire (Table 7.2). This suggests default items like:

- Messages (read/write)
- Status
- Notification
- Friends
- Profile

The defaults will offer quick access to what most users want and allow them to find all other items through the 'more…' link if required. With a suitable default, users with different priorities will only need to provide minimal customisation.

7.4.2 The Removing of Unimportant Items and the 'more...' Link

Another aspect of prioritisation is the removing of unimportant or rarely used items. As described in Chapter 5, low priority items are removed and replaced with the 'more...' link.

All participants liked the idea of hiding the unimportant items, especially for mobile devices, with 17 participants preferring to determine which items to hide.

16 of the 18 participants firmly supported the idea of hiding the items. Hiding the unimportant items, according to the participants, would allow them to have uncrowded pages and thus

would ensure the important items were at the top of the page. Participants also believed that having uncrowded pages with only the important items would allow them to browse the page easily and without confusion and that prioritising items would help them access important items more quickly. Also, the page would be easier to navigate around with less scrolling required.

However, two participants regarded the hiding of unimportant items as a good idea, but preferred to have everything visible. One participant thought it would be easier for her to find or use the items if she needed to. The other participant was concerned that she might forget the availability of the removed items.

In addition, two participants expressed their dissatisfaction with the location of the 'more...' link to reveal the removed items. One participant suggested that the link should be at the top of the page. This is an issue of participants' personal preference. As discussed earlier, allowing users to assign a different priority to the 'more...' link would resolve this problem.

7.4.3 Re-ordering Items Based on Their Priority

Another aspect of prioritisation is the re-ordering of items displayed based on their priority. The highest priority items are displayed first. Our result showed mixed views.

Six participants liked the idea particularly if they could determine the order. They believed the re-ordering of items would allow them to have the most important or favourite items at the top of the page. Again, as in the previous section, participants believed the re-ordering of items would assist them to access important items faster.

In contrast, the re-ordering of items was not important to five participants. They claimed that, as long as only the important items available, the order would not be an issue even for mobile devices.

7.4.4 Prioritisation (Customisation) vs. Personalization

As disccused in previous sections, participants generally wanted to be able to control the prioritisation so that they would know which items were removed and would not forget the availability of those items. This was because participants believed they know what are important to them.

Three participants believed that websites could predict the important or most frequent items that users use; these participants clearly expressed that they want to have the control and the final say of which items are displayed or removed on their page. This results showed that as

users have individual preferences, allowing them to choose items of their interest is a good idea.

7.5 Summary

The results showed that *adaptive page* that uses the 'One Web' approach of having only a version of pages delivered and prioritised to different devices produces similar pages (similar look and feel, content, and layout structure). The similarities, due to the prioritised pages coming from the same pages as on the desktop, offers familiarity to participants because it allows general structure and page items to look similar and be in the same or similar location as on the desktop.

The results on the number of tasks completed and the task completion time for the mobile versions showed that more participants completed the tasks on our mocked up and prioritised Facebook page than on the actual Facebook mobile version. On average, participants also performed the tasks faster on the mocked up mobile version regardless of the participants' experience with the Facebook mobile site or the order they trialled the Prioritised version.

In contrast, the number of completed tasks and the mean completion time were similar for both our mocked up full site and the Facebook full site compared on the laptop. Our trial of both mocked up and the actual Facebook full site showed that designing the pages in a way that allowed prioritisation did not degrade the user experience. The numbers of completed tasks are the same for both sites, and the time taken to complete the tasks were similar.

The trials have shown that the way participants carried out the tasks was determined by their knowledge gathered from their experience with the actual Facebook full site. It was clear that participants was comparing what they saw on the mobile with what they were familiar with on the desktop and thus influenced participants' opinion of each version.

It might not be possible to achieve exactly the same user experience on mobile devices as that of the desktops. However, the results suggested that the mocked up version offers a better user experience than the dedicated Facebook mobile version when accessed from the mobile phone and similar experience as the Facebook full site version when used on the laptop.

One particular theme observed was that similarities to the Facebook full site particularly on the locations of items have greatly affected participants' performance and opinion on the prioritised version. In contrast, the dissimilarities to the Facebook full site caused confusion and problems with completing tasks on the Facebook mobile site.

The majority of the participants preferred the prioritised version to the Facebook mobile mostly due to its similarity to the Facebook full site and the Facebook full site to the Prioritised full site only because of the professional look it has.

Additionally, the results from the interviews showed that the majority of participants supported and liked the idea of prioritisation that is to show only the items of their interest especially for their mobile devices. Most participants would like to determine the prioritisation order themselves. This is expected as participants may have different preferences.

The following chapter will look at the performance of the prioritisation engine, which is used to generate the page displayed when a user visits the prioritised site (adaptive page).

Chapter 8
Performance Evaluation

In the previous chapter, we discussed the user trials conducted to evaluate the usability and user experience of pages produced by the prioritisation engine. Results showed that our prioritised page provided a better user experience when compared to the actual Facebook mobile version, and a similar experience when compared to the actual Facebook full site version.

This chapter discusses the evaluation conducted to determine the performance of the prioritisation engine. As described in Section 5.6, the prioritisation requires a database of preferences to be accessed followed by the rearrangement and display of items on the page. This process will take time. It is important that the extra processing time is not so long as to affect the user experience. We also need to understand how the processing time is impacted by the size of pages and the number of users and preferences.

First, we outline the preparation taken to conduct the performance test in Section 8.1. Then, Section 8.2 looks at the results where we outline the impact of database sizes on the prioritisation process (Section 8.2.1); the impact of number of page items on the prioritisation process (Section 8.2.2); and the impact of number of preferences on the prioritisation process (Section 8.2.3). Then, we look at other factors affecting the performance (Section 8.3). Finally, Section 8.4 provides a summary of this chapter.

8.1 Background of the Performance Test

The goal of the performance test was to determine the efficiency of the prioritisation system. The tests conducted were designed to find the effect on the delivery of a web page to a user caused by the prioritisation system.

There are different stages in the prioritisation system as shown in the flowchart below (Figure 8.1); timestamps were recorded before and after the execution of the main process blocks (t_0 to t_5) to calculate the actual time spent during each phase.

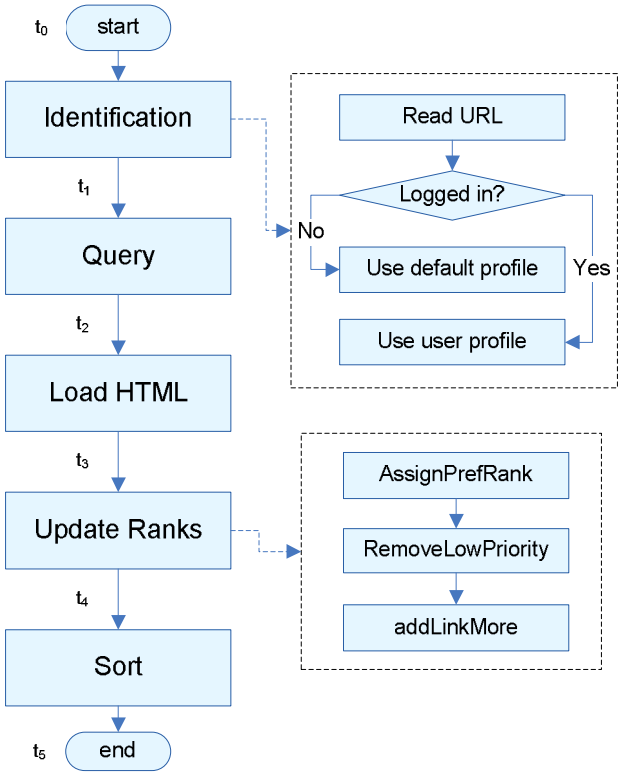


Figure 8.1 Flowchart of the prioritisation process

8.1.1 Factors Affecting Processing Time

The time taken for the prioritisation process depends on several factors. To evaluate the influence of these factors, tests were run to investigate the performance of the prioritisation process for different:

- sizes of database
- number of items on the page
- number of preferences (items selected to be displayed)

Table 8.1 summarises the steps in the prioritisation process and factors that may affect the performance of each step. The size of the database should only affect query response time, as this is the only time the database is involved in the prioritisation process.

Table 8.1 Summary of prioritisation processes and factors affecting performance

Process	Description (see Section 5.6)	What would affect the performance		
		Database size	Number of page items	Number of user preferences
Identification	Identify page, user, and device	×	×	×
Query	Query users' cut-off and preferences for page	✓	✓	✓
Load HTML	Load base/template page	×	✓	×
Update Rank	Update items' ranks	×	✓	✓
▪ Assign Preferences	Assign preference to items. Items without preferences will get the default low priority value.	×	✓	✓
▪ Remove low priority	Remove low priority items (items with a preference greater than the cutoff)	×	✓	✓
▪ Add link 'more...'	Add the 'more..' link to the page (if there is any items removed)	×	×	×
Sort (XSLT)	Apply XSLT to sort items based on their preferences and output the result	×	✓	✓

To test the three factors that might affect the processing time, we prepared pages and databases of different sizes. The preparation process is discussed next.

8.1.2 Preparing the Pages and the Databases

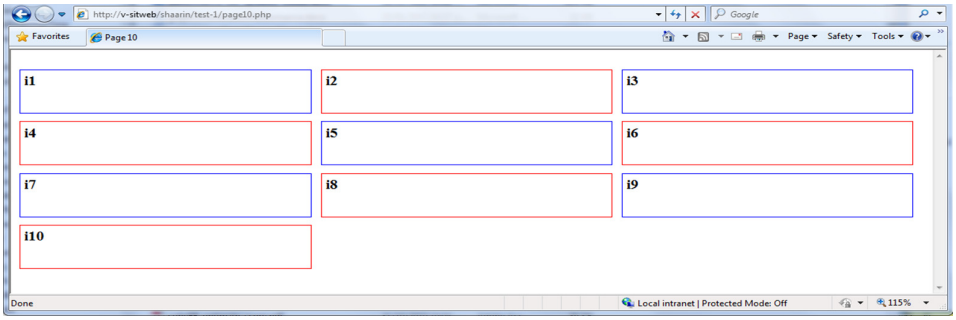
A page item (or a prioritisable *div*) is a *div* tag with an attribute *id* (see Section 5.2). To test the effect of page items on the prioritisation, we developed six pages - page10, page20, page30, page40, page50, and page100 - each with a different number of items. Page10 had 10 items (see Figure 8.2a). Page 20 had 20 items, 10 from page10 and 10 new items (see Figure 8.2b). On the next three pages, the items from the previous page were repeated and 10 new items added. For example, on Page50, items from Page40 were repeated and 10 new items were added. For Page100, all the items in Page50 were repeated and 50 new items were

added. These sizes were chosen, as we believe they represent the general sizes of web pages. It is unlikely that a page would have more than 100 items.

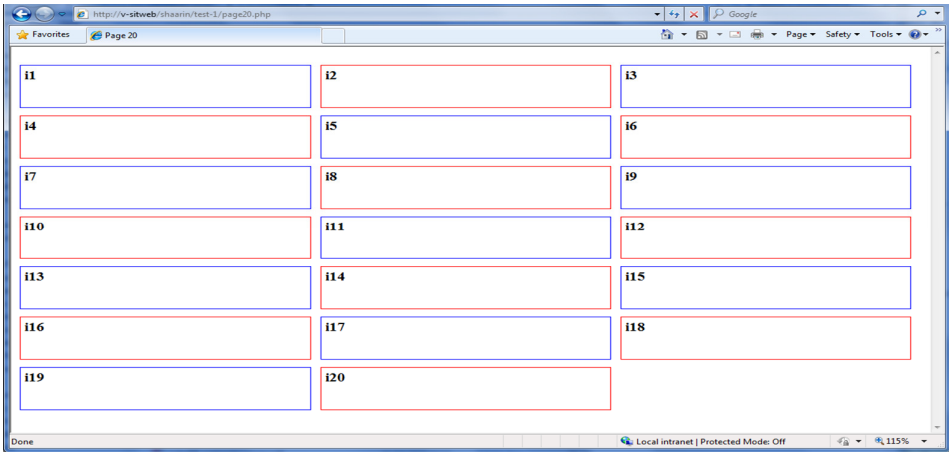
Table 8.2 summarises the details of the page and Figure 8.2 illustrates the first two pages.

Table 8.2 Details of pages

Page	No. of items	Items
page10	10	i1, i2, i3, i4, i5, i6, i7, i8, i9, i10
page20	20	(items in page10), i11, i12, i13, ..., i18, i19, i20
page30	30	(items in page20), i21, i22, i23, ..., i28, i29, i30
page40	40	(items in page30), i31, i32, i33, ..., i38, i39, i40
page50	50	(items in page40), i41, i42, i43, ..., i48, i49, i50
page100	100	(items in page50), i51, i52, i53, ..., i98, i99, i100



a) Page10 – 10 items



b) Page20 – 20 items

Figure 8.2 Examples of pages with 10 items and 20 items

As described in Section 5.4 the preferences for users on different devices are kept in a database. This database needs to be queried to find the preferences for the current user. Clearly, as the database grows this query will take more time. There is one row in the database for each item preference for each user for each different type of device they use. To test the effect of the database size on the prioritisation, particularly on the query time, we prepared several databases with different numbers of rows in the preferences table: 1000; 10,000; 50,000; 100,000; 150,000; 500,000; and 1,000,000. Each row represents a one item specfied for a user on a single device. A 50,000 row table would be the size expected for 5000 users each specifying five preferences for two different devices; a 1000K row table would represent 200,000 users who specify 5 preferences for a single device. The comparisons were made on the same basis (fixed number of preferences and page size). It is important to remember that not all users will specify preferences as most will accept the default preferences for each device if they are carefully developed. We feel these numbers would be reasonable for medium to large businesses and thus, useful for us to test. For sites with very large numbers of users (e.g. Facebook) who choose to apply their own prioritisation, additional optimisation will likely be required.

8.1.3 Test Method

We performed a number of tests (as outlined in the following sections) in which the factors that might affect the processing time were varied.

For each test for a given page size, database, and number of preferences as described in Section 8.1.2, we first created a static page. To create the static page, the output page from the prioritisation process for each test was saved as a static HTML page so that the time to load it could be compared with the time taken to prioritise the page.

We ran the prioritisation from a program which allowed us to record the time for each stage shown in Figure 8.1. We also ran the static page within the same program and recorded the time taken to load it. Both the static page and the prioritisation were run in the same program to ensure that they were run under the same conditions. This process was repeated 15 times in order to minimise the effects of external factors on the times. Then, the mean time and standard deviation were calculated. Figure 8.3 summarises the structure of the test.

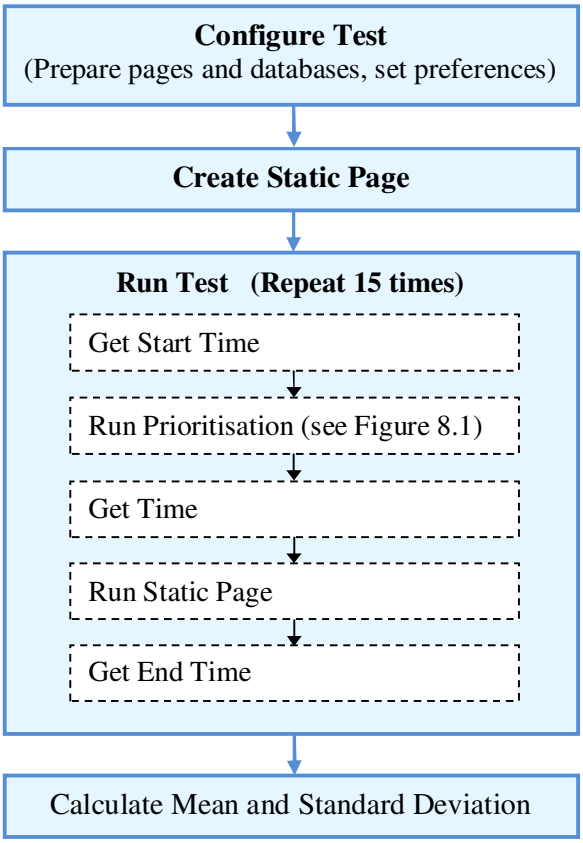


Figure 8.3 Test structure

8.2 Results

This section looks at the results for each test.

8.2.1 Effect of Database Size on Prioritisation

The purpose of this test was to determine the effect of the database size (number of rows) on the prioritisation process.

The database size will increase as the number of preferences each user declares for different devices increase. We investigated the following database sizes 1K, 10K, 50K, 100K, 500K, and 1000K records. These databases store the users' preferences (see Section 5.4). The tests were run on a page with 50 items. A 1000K database would be the size expected for 200,000 users each with five preferences declared for a page.

The number of items with a preference (less than or equal to the cutoff) in the database was set to five. The other items without a preference in the database were assigned a default low priority value by the Prioritisation engine (see Section 5.6.3). Each test was run 15 times and

Table 8.3 shows the mean time and standard deviation for each stage of the prioritisation process.

Table 8.3 Time taken (in milliseconds) to prioritise a 50-item page with five preferences over different database sizes

DB sizes (thousands of rows)	Identification		Query		Load HTML		UpdateRank		Sort		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	10.61	1.36	2.06	0.14	4.30	4.40	1.29	0.04	0.99	0.11	19.32	5.46
10	10.26	0.40	2.06	0.08	3.05	0.15	1.30	0.06	0.93	0.04	17.69	0.50
50	10.12	0.24	2.15	0.11	3.06	0.20	1.29	0.03	0.95	0.06	17.64	0.44
100	10.29	0.35	2.13	0.12	3.08	0.18	1.29	0.08	0.94	0.05	17.79	0.49
150	10.20	0.51	2.16	0.12	3.16	0.21	1.34	0.11	0.96	0.06	17.90	0.70
500	10.29	0.81	2.29	0.19	3.13	0.26	1.29	0.03	0.99	0.14	18.06	1.16
1000	10.35	0.35	2.35	0.14	3.16	0.15	1.30	0.05	0.99	0.11	18.24	0.56

The large standard deviations in the first row of Table 8.3 above were due to a few outliers in the data from the first run of our test. This could be due to the server load, the server processing time, and/or the network load and those particular times (see Section 8.3). Taking out the outlier gave us reasonable data.

As stated in Section 8.1.1 the database sizes should only affect the query time since that was the only time the database was involved during the prioritisation process. As expected, the size of the database has the most impact on the query time as shown in Figure 8.4 where a linear trend line has been added.

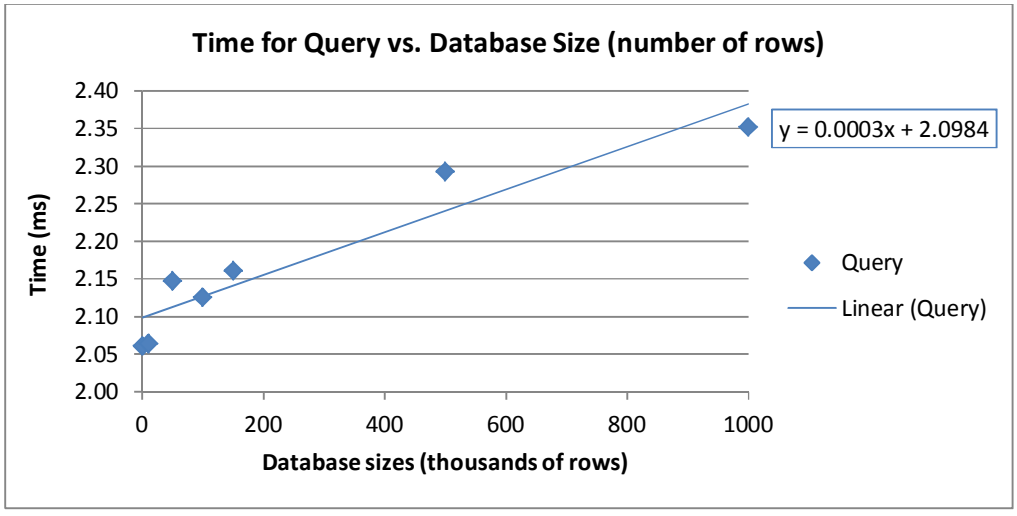


Figure 8.4 Time for queries over database size (thousands of rows)

Increasing the size of the database from 1K to 1000K records increased the time taken by the query by only about 0.3 milliseconds. If this linear trend continues for larger databases then the additional time for increased rows should be negligible. This test was undertaken with a standard relational database without any query optimisation. For much larger databases, different data structures or query optimisation could be investigated if query time became an issue.

8.2.2 Effect of Number of Page Items on Prioritisation

The purpose of this test was to determine the effect of the number of page items on the prioritisation process.

The number of page items varies according to pages. We investigated the following different number of page items - 10, 20, 30, 40, 50, and 100 items. The tests were run on a database with 1000K rows. The number of items with a preference (less than or equal to the cutoff) in the database for each page was set to five. The other items without a preference in the database were assigned a default low priority value by the Prioritisation engine (see Section 5.6.3) and were removed from the final display. As with the previous test, this test was run 15 times and Table 8.4 shows the mean times and standard deviation for each stage of the prioritisation process.

Table 8.4 Time taken (in milliseconds) to prioritise pages with different number of page items with five preferences (items to be displayed in the final page)

No. of page items	Identification		Query		Load HTML		UpdateRank		Sort		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
10	10.41	0.35	1.53	0.05	2.69	0.18	0.29	0.03	0.86	0.05	15.85	0.45
20	10.49	0.29	1.75	0.09	2.95	0.18	0.51	0.03	0.86	0.04	16.64	0.38
30	10.62	1.17	1.91	0.12	3.00	0.28	0.75	0.04	0.96	0.09	17.31	1.39
40	10.26	0.41	2.09	0.10	3.04	0.22	0.99	0.04	0.96	0.11	17.42	0.70
50	10.35	0.35	2.35	0.14	3.16	0.15	1.30	0.05	0.99	0.11	18.24	0.56
100	10.38	0.61	3.21	0.13	3.57	0.32	3.28	0.36	1.13	0.11	21.66	1.20

Results showed that the increase in the number of page items has the following effect on each process:

- **Identification**: The identification time is independent of the number of page items. It should remain similar for every case, but the results showed above may be affected by the server's load and processing and other factors discussed in Section 8.3.

- **Query**: The increase in query time may be affected by factors such as the database's indexing and cache, and the I/O operations and activities.
- **Load HTML**: This increases with the number of items, but this increase will be similar for the prioritised and static pages.
- **UpdateRank**: As the number of items increase, the Update Rank time increases because the system needs to assign a preference to more items; and based on the preferences, removes items greater than the cutoff (the low priority item).
- **Sort**: The sort time should not be affected as the number of items to be sorted (the number of items to be displayed) is fixed.

Figure 8.5 shows those processes affected by the prioritisation process as a result of different numbers of page items.

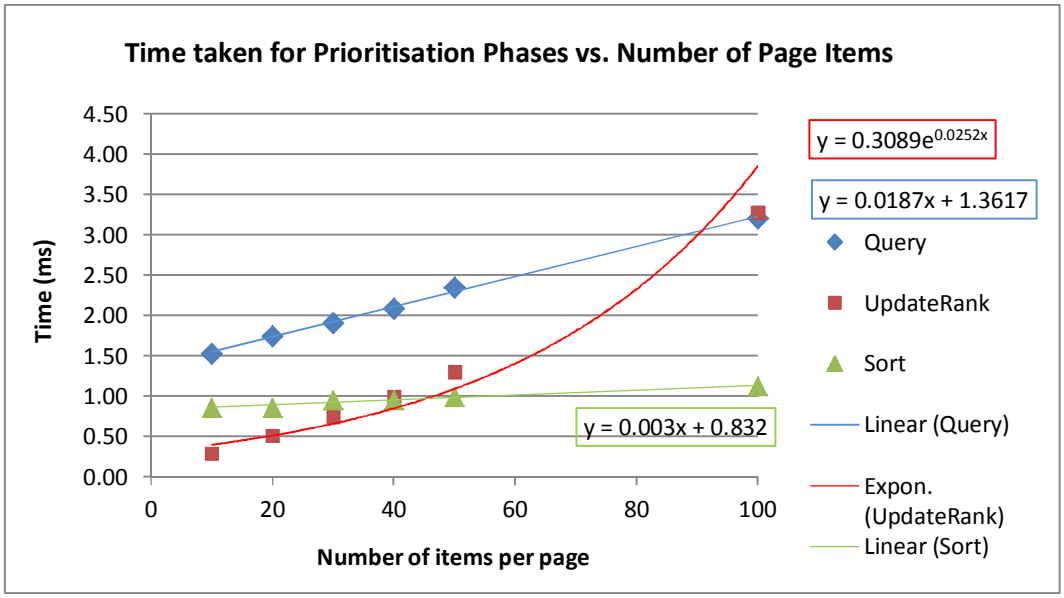


Figure 8.5 Time for different prioritisation phases over number of page items

The linear trends for Query and Sort show that increasing the number of items in a page from 10 items to 100 items increased the time taken by the Query by about 2 milliseconds; and increased the time for Sort by only about 0.3 millisecond. The trend for UpdateRank shows that the time would increase exponentially. If the trends continue for pages with more items then it suggests that time could be an issue for UpdateRank and Query. However, it is unlikely that the page will have large number of items, so this is unlikely to cause any problem. This test was undertaken on a prototype without any code optimization. Although it

is unlikely that a page will have more than 100 items, code optimization mechanisms could be investigated.

8.2.3 Effect of Number of Preferences (Items Selected to be Displayed) on Prioritisation

The purpose of this test was to determine the effect of the number of items selected to be displayed on a page (preferences per page) on the prioritisation process. The number of preferences refers to the number of items with specified preference in the database (see Section 5.6.3). In this test, all items assigned a preference were given a preference less than the cutoff level. Only these items are kept and available in the final prioritised page. This page (or any page that has at least one item with a preference) is referred to as the prioritised page or the ranked page.

We investigated the following numbers of items chosen to be displayed (i.e. 5, 10, 15, 20, 25, 30, and 50) on a page with 50 items. 50 preferences on a 50 items page indicates that every item on the page was assigned a preference. The only difference between a non-ranked page and a completely ranked page may be the order that items are shown in. As with previous tests, each test was run 15 times and Table 8.5 shows the mean time and standard deviation for each stage of the prioritisation process.

Table 8.5 Time taken (in milliseconds) to prioritise a 50-item page with different number of preferences (items to be displayed in the final page)

No of Preferences	Identification		Query		Load HTML		UpdateRank		Sort		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
5	10.35	0.35	2.35	0.14	3.16	0.15	1.30	0.05	0.99	0.11	18.24	0.56
10	10.62	0.52	3.03	2.33	3.27	0.26	1.29	0.05	1.09	0.09	19.38	2.48
15	10.18	0.38	3.72	4.88	3.07	0.18	1.30	0.09	1.14	0.08	19.50	5.04
20	10.01	0.27	2.40	0.05	2.98	0.14	1.31	0.05	1.19	0.06	17.99	0.32
25	10.18	0.35	2.53	0.15	3.11	0.32	1.34	0.10	1.29	0.08	18.55	0.78
30	10.21	0.39	2.54	0.10	3.10	0.19	1.35	0.08	1.39	0.09	18.71	0.68
50	10.22	0.42	2.78	0.16	3.24	0.20	1.37	0.02	1.69	0.12	19.46	0.66

Varying the number of items to be displayed (items with preference stored in the database whose value is less than or equal to the cutoff level) has the following effect on each process:

- **Identification**: This should remain similar for every case, but the results showed above may be affected by the server's load and processing and other factors discussed in Section 8.3.

- **Query**: As the number of items to be displayed (items with a preference) increases, the number of rows returned from a query for a particular user and device will increase.
- **Load HTML**: The load time should remain stable as the page item is fixed; and the time will be similar for the prioritised and the static page.
- **UpdateRank**: The time for UpdateRank process will be unchanged, as the process has to go through the same number of page items.
- **Sort**: The Sort time increase because, as the number of items with a preference increases, more items need to be sorted.

As expected, the impact of number of preferences was greatest on the sort time as shown in Figure 8.6 where linear trend lines have been added for Sort and updateRank.

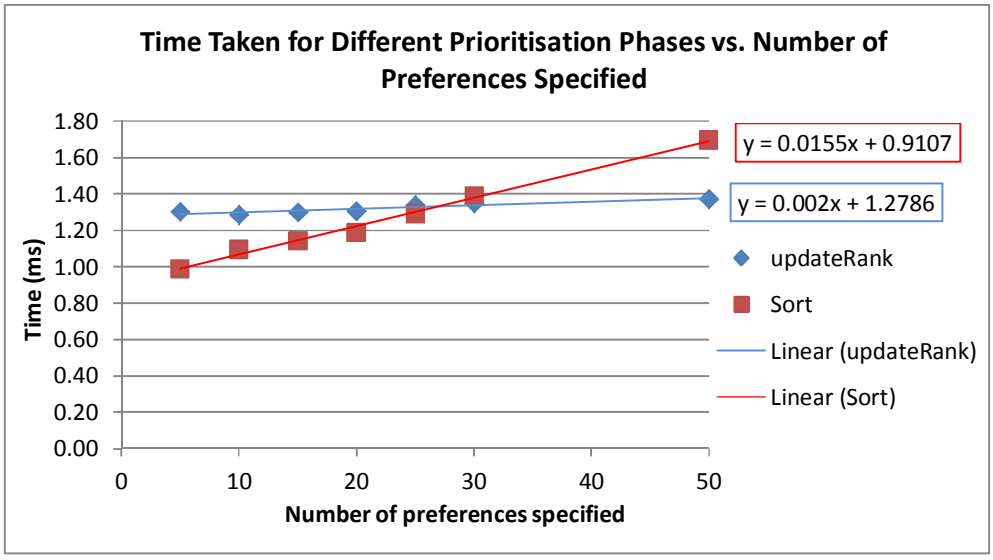


Figure 8.6 Time for different prioritisation phases over number of preferences specified

Increasing the number of displayed items from five to 50 increased the Sort time by only about 0.7 milliseconds and increased the updateRank time by about 0.1 milliseconds. If the linear trend continues for a larger page with more items and more preferences, the additional time for increased page items or number of preferences should be negligible. As discussed in Section 8.2, it is unlikely that a page would have more than 100 items; however, if time became an issue, sorting and code optimization mechanisms could be investigated.

8.3 Other Factors Affecting the Performance

From the 15 runs of each test, we recorded a few time differences (outliers), which caused the high standard deviation as shown in our results. These outliers could be due to other factors such as the server load, the server processing time, and/or the network load at those particular times. We did not explicitly investigate these factors.

Results also showed that the majority of the prioritisation time was spent at the identification stage. This time includes the time taken to initialise and establish connection to the database and the external programs or files. It includes the time to detect and identify users, devices, and pages to be prioritised (see Section 5.6.1). However, the additional 10 milliseconds should not cause the user experience to be affected unduly.

8.4 Summary

The purpose of the evaluation was to investigate the performance of the prioritisation process and impact on the page load/display time. To determine the extra processing time the prioritisation added we compared the time taken to prioritise a page with the time to load an equivalent static page.

Results showed that the time taken to prioritise a page was higher than the time taken to load the static page. To illustrate, on a database with 1000 records, prioritising a 10-item page with five items assigned a preference (five items with a preference) added around 19 milliseconds compared with loading the static page. Similarly, on a database with 1000K records, prioritising a 50-item page with 50 items of preferences added around 24 milliseconds than only loading the equivalent static page.

When the data was analysed, results showed that the database size has the most impact on the query time. The number of page items has the most impact on the update rank time and the query time; and the number of preferences has the most impact on the sort time. As discussed earlier, the use of code and query optimisation could be investigated to optimise the prioritisation time.

The overall total time spent to deliver (prioritise and display) a prioritised page including the network transmission delay and rendering time should be below the general benchmark website load times of 2-3 seconds (Gomez, 2010a) and should be within the response time that most users are willing to wait for websites to load on their mobile devices (Compuware, 2011; Gomez, 2010b).

Chapter 9
Discussion and Conclusion

The main purpose of this study was to investigate a suitable approach to providing users with a consistent but tailored web experience across different devices. Users differ in their characteristics and preferences. Devices differ in their features and capabilities. Web pages differ in their structures, purposes, and contents. Delivering web pages to different devices that meet users' needs within the devices' capabilities is challenging.

In this study, we aimed to answer the following research questions:

- What are prevalent mobile web issues?
- How can we ensure that users get similar web pages and browsing experience while accessing web pages from different devices?
- Can an adaptive page and prioritisation approach tailor web pages adequately for users with different preferences and devices?

To understand aspects that could affect mobile web, we reviewed web and mobile device technologies. We also reviewed current approaches to delivering websites to mobile devices focusing on adaptation approaches (see Chapter 2).

In order to investigate issues with accessing the web using mobile devices we conducted a number of surveys as described in Chapter 3. We found that Social Networking Sites (in particular, Facebook) are the most commonly accessed sites. Based on this finding, we conducted a user trial comparing how participants performed a set of tasks on the Facebook full site version compared with the mobile site version. General findings from our surveys and user trial suggest that participants expected to have the same or similar site with a similar browsing experience on their mobile devices as on their desktops. Differences confused users. Participants also wanted to have an un-crowded page adequately presented on the mobile device. Our findings were also backed up by other research (Compuware, 2011; Gomez, 2010b; Kane et al., 2009).

To overcome the dissimilarity of pages on different devices, we have pursued the idea of device adaptive pages to provide similar pages delivered to different devices and to provide similar browsing experience across devices (see Chapter 4). In this thesis, we have focused on a method of providing a consistent experience across different devices. We proposed an automatic server-side adaptation approach through prioritisation. The page content adaptation is performed based on a user's preferences and the types of device accessing the page. The aim was to allow web page items be displayed, removed, or re-arranged, based on the preferences specified for each user and device. The page's overall structure or the parent-child relationship of page items is preserved to retain similarity to the full site version.

To test and validate the prioritisation approach, we implemented a server-side Prioritisation engine prototype as discussed in chapter 5. The prioritisation engine operates on the original page's DOM tree and uses XSLT to modify the page structure. We defined a structure for an adaptive page (original base page) using tags to identify proritisable elements.

To test whether the adaptive page and the prioritisation engine can tailor web pages adequately for users with different preferences and devices, we replicated Facebook pages using the structure required by our engine (see Chapter 6). We then conducted user trials comparing the full mock version and the prioritised delivery of these pages with the actual Facebook full site version and the Facebook mobile version.

To test that the prioritisation will not cause noticeable overheads, we evaluated the performance of the Prioritisation engine. Results showed that the time taken for the prioritisation process is reasonable.

Section 9.1 presents the overview of approaches to delivering web pages to mobile devices. Section 9.2 discusses the adaptive page and the prioritisation engine. Section 9.3 discusses our main findings – the usefulness of the prioritisation engine and the prioritised pages. Section 9.4 suggests improvements for the prioritisation system. Section 9.5 discusses avenues for future work. Section 9.6 presents our research contributions. Lastly, Section 9.7 concludes the thesis.

9.1 Overview

There are two main approaches to delivering web pages to mobile devices - to manually develop separate mobile pages for mobile devices or to automatically adapt web pages to mobile devices. While developing separate dedicated web pages for mobile devices can

optimise the presentation (visualisation) of the pages on mobile devices, this approach adds to overhead and causes additional maintenance issues. Developers need to update and maintain multiple versions. In addition pages updated on one version may not reflect in another version. Thus, users will get inconsistent pages (or content) on different devices.

On the other hand, the approach to automatic adaptation requires only one version of web pages be developed. However, existing automatic adaptation approaches seem to focus only in delivering the content of pages to mobile devices; with less consideration of the structure and thus the way they are presented to ensure similar pages delivered across different devices. In current approaches the structure of web page is re-segmented or re-constructed which may cause users more clicking and loss of orientation within the websites, our approach overcomes this issue.

9.2 Device Adaptive Pages and Prioritisation Engine

Usability studies of mobile adaptation conducted by Roto and Kaikkonen (2003) suggests that adaptation engines should preserve, as much as possible, the original structure of the full site version in order to allow users to associate and relate the mobile version with the original one.

We have endeavoured to ensure consistency is retained between devices with our approach. We defined an adaptive page - a structure for a web page (using *div*s) that allows the same page to be prioritised and delivered to different devices based on users' preferences (see Chapter 5). We developed a prioritisation engine that prioritises the adaptive page (or the base page) based on the preferences. This approach requires little effort from the developers and users. The web developers need to have their web pages structured using *div*s; and ensure each item (*div*) to be prioritised has a unique *id* within a page. Developers should provide a default items (preferences) for each type of devices. The users could accept the defaults items or set their preferences of items of their interest based on their devices.

Our results show the feasibility of an adaptive page approach to produce similar pages for different devices. Our Prioritisation engine enables users to specify which items they would like delivered to different devices. This is done in such a way as to preserve the page's parent-child relationships, ensuring the overall layout and structure of the original page is maintained. Our trials' results showed that this similarity and familiarity helped users to have a good browsing experience, in which they were able to relate and recall their experience with

the familiar full site version, thus performing tasks easily. In comparison, users had difficulty with navigating the differently structured pages for Facebook desktop and mobile version.

Two other adaptation approaches, PageTailor (Bila et al., 2007) and Proteus (Caetano et al., 2007), are similar to ours and were discussed in Chapter 2. PageTailor is a client-side approach that allows users to show, hide, and re-arrange blocks of content once and is automatically applicable for other pages of similar structure. This only works on mobile devices with Minimo browser. Proteus is a proxy-side adaptation architecture which converts pages into conventional HTML of summarised text with an appended 'more' link to expand the page or converts pages into thumbnail depending on users' preference. Table 9.1 compares the Prioritisation engine to these other approaches.

Table 9.1 Comparison of the Prioritisation engine to other similar approach

	Prioritisation	**PageTailor (Bila et al., 2007)**	**Proteus (Caetano et al., 2007)**
Approach (where)	Server	Client / Proxy	Proxy
How	Show, remove, and re-arrange items of interest, and adds 'more...' link.	Show, hide, and re-arrange items of interest.	Convert and compress page to a summarised text and appends 'more' link, and/or convert page to a thumbnail. No re-arranging of item
Description	Uses the DOM and XSLT to prioritise the page Device and browser independence.	Use the DOM and XPath to apply the customisation Device dependent - require devices with Minimo browser.	Uses the DOM to analyse page, and a similar algorithm to the Vision-based Page Segmentation (VIPS) algorithm to highlight content.
User preferences	Store the *id* and *rank*s of items based on users and devices	Store XPath of content	Store profile e.g. compression rate, area of interest
Developer	Need to specify prioritisable *div*s by assigning unique *id* to each.	Do not need to do anything; and cannot determine (do not have full control of what to customise.	Do not need to do anything; do not have control over what to customise.
User	Provided with default page; only need a small customisation if needed	Need to perform the customisation on mobile device	Need to do the customisation – specify values for items (e.g. font size)

Our implementation was based on the assumption that web developers (or other stakeholders involve in decision making in the website development) would easily detect and determine the areas of content to be prioritised (the *div*s that could be prioritised) and would follow the general recommendation that each *id* within a page should be unique.

Identifying items based on its *id*s is a straightforward and an ideal approach. However, while it is based on the HTML recommendation that items should have a unique *id*, this may not be strictly followed in reality.

While this approach has positive implication to the users, it may introduce extra work for web developers or content providers. Users can specify page' items and order of appearance based on their preferences. This will ensure that users get only the specified content. On the other hand, content providers need to carefully ensure that items to be prioritised (prioritisable items) have unique *id*s. In practice, this may add more effort to them.

Alternatively, another approach as used by Bila et al. (2007) and Kao et al. (2009) detects and records the path to the unique items. This approach could overcome the possibility of items not having *id*s or unique *id*. This approach uses and stores the XPath expression to identify the items. While this may lessen developers' effort in assigning unique *id*, it may not be ideal in all cases in reality as using XPath is only suitable and works well for pages with a structure that is rarely changed.

9.3 Usefulness of the Prioritised Pages

Participants' performance and browsing experience on the prioritised version is better than on the dedicated mobile version of Facebook and indicates the usefulness of the prioritised page. Participants preferred and performed faster on the prioritised version than on the Facebook mobile version. Our qualitative and quantitative results appeared to triangulate well.

Providing similar web pages on mobile device (to those on the desktop version) enables users to have effective navigation and web browsing. Our studies showed that mobile web pages that are similar (with the same links/menus and a similar structure) to the familiar desktop version help participants to locate items of interest faster. For example, five participants stated that it was easier for them to use the prioritised version as it has similarities to the actual desktop version. Our findings support those of Shrestha (2007) who found that users' familiarity with the desktop web pages aids them to find content on mobile display easily. This shows that navigating in familiar pages is easier with less mental strain (Kaasinen et al.,

2000). The results suggest that the adaptive page through the prioritisation engine could produce similar pages to desktops and mobile devices. This was the main reason for participants preferring this version.

Our findings confirm those of Kaasinen et al. (2000) and Roto and Kaikkonen (2003) that as long as a navigation path is familiar and is not altered, alteration in page layout will not cause problems. This proves that the page items such as links and menu should retain the same name; the websites should maintain the same logical structure, and page items should be in similar locations across different devices.

As content (visible items and removed items revealed using the 'more...' link) are displayed on the same page, the prioritisation approach reduces the loss of orientation problems caused by splitting pages into subpages or creating extra pages. This can be seen from the observation that participants appeared less confused while performing tasks on the prioritised version than on the Facebook mobile version.

The prioritisation engine removes unwanted content and reorders important content to the top; this helps users to find important content easily. Sorting pages in this way minimises the scrolling effect (Tsandilas, 2003) and contributes to an improved user experience.

Participants expressed support for prioritisation as it allows them to have the important items of interest displayed based on the device they are using to access the page. Displaying only important items, in order of importance makes pages less crowded and easier to access on their mobile devices according to participants.

9.3.1 Developer Driven Prioritisation vs. User Driven Prioritisation

Participants had different views on which items are most important. This emphasises the importance of allowing users to have their own preferences (determine the items to show and their order of appearance) for web pages.

However, an initial developer driven default is a useful starting point. Our results provided empirical data to define sets of default. There was an agreement between participants of the important items to be displayed. This suggests that users will not need to do their own customisation most of the time. Only minimal customisation is required if there is a need.

9.3.2 Prioritisation Overhead

During web browsing, the time to deliver a page is a critical factor. It is therefore important that any adaptation system does not impose a significant overhead in delivering a page.

Results from the performance evaluation, discussed in Chapter 8, showed that the Prioritisation engine only imposes a small overhead to the Prioritised pages. It took around 24 milliseconds extra to prioritise a 50-item page compared with loading its equivalent static page. The additional time would be negligible. If the time to prioritise a page increases for any case, further optimisation of code and queries could be undertaken.

9.4 Proposed Improvements

This work was a proof of concept prototype and consequently there are a number of improvements and extensions that could be made.

The Prioritisation engine currently provides access to removed content (i.e. text and graphics) by providing one 'more...' link per page. Providing the 'more...' link for every main block of content (the parent node) may improve users' browsing experience on the prioritised web and reduce the amount of content redelivery that occurs with the current approach.

The Prioritisation engine, uses user agent strings to detect the types of device, but does not currently take into account the device capabilities. Taking the different capabilities into account may improve the way the page is prioritised and in turn, improve users browsing experience. In addition, the prioritised page produced may not be as "high-quality" as pages specifically developed for specific devices.

It should be noted that the Prioritisation approach proposed here might not be suitable to adapt all types of websites with rich amount of different types of content. This is because, while prioritisation is suitable to re-arrange and hide items, pages that focus on the multimedia presentation, such as YouTube, may require high-end phone and, multimedia or content format or fidelity adaptation such as the work done by (Mohomed et al., 2007), which were beyond the scope of this work.

Most of our trials participants were students at Lincoln University, which may not represent the actual population of Facebook users. The difference of their demographic characteristics and experience with mobile devices and mobile web to the general population may be argued as a biased sample. In addition, the results also may not be generalised due to the small sample size. Conducting the trial to a larger sample sizes may produce more generalizable results.

9.5 Future Work

The work discussed in this thesis focuses on making the prioritisation engine produce similar web pages to different devices by re-arranging the page but retaining the items' parent-child relationship. The content remains unchanged. A more challenging approach is how to adapt other content (such as images) depending on a user's preferences and device capabilities. Extending the functionality of the Prioritisation system to cope with different delivery context (users and devices) should be explored.

While the focus of this research is to prove the practicability of the Prioritisation approach, an easy to use interface that allows users to customise their preferences from any devices would be useful. This research has not provided nor tested a user interface for users to perform individual prioritisation. A user interface for developers to specify prioritisable items would also be useful. In addition, a hybrid of customisation and personalisation could also be explored to provide a more robust system.

Other alternative approaches to perform the adaptation discussed in this thesis are left for future work.

9.6 Research Contributions

We have identified a set of common and frequent problems users encountered while accessing the web from mobile devices. The problems are mostly caused by the websites being different across devices; and users expect a comparable browsing experience regardless of the device used to access the page.

We compared three adaptation approaches (client-side, proxy-side, and server-side) and have identified the strength and weaknesses of the approaches to tailor websites to mobile devices. We discarded client-side approach as it requires for particular browser or plug-ins be installed on users' devices; not all users are willing to do so. This approach also left the developers with only little control over the displayed websites on devices. On the notion that users have to perform extra work as to direct their mobile devices to a proxy site and developers have less control over which items can be adapted, we did not choose proxy-side adaptation.

We designed and developed a prototype of a server-side adaptation engine that uses a prioritisation technique to deliver adaptive pages to different devices based on users' preferences. Our system does not require installation of particular browsers or plug-ins, and

do not require users to set the mobile to go to a proxy. We identified a few strength and weaknesses of our systems which are open for future improvements.

We conducted an empirical evaluation, investigating the effect of our adaptive page prioritisation approach on users' web experience. Most current adaptation systems have not been tested with real users and real device.

We also examined the performance of the prioritisation engine and identified factors that could affect the performance.

9.7 Summary

As discussed in Chapter 1, the number of internet users has surpassed 2.4 billion; the number of mobile web users is 1.2 billion. This number is increasing. Mobile web access has become prevalent. It enables users to access the web from anywhere and at anytime. However, a few issues hamper users' browsing experiences. These issues include the low usability and a poor user experience of accessing websites on different devices, primarily caused by sites that are mostly designed and optimised for desktops, inconsistency between versions of web for different devices, variation in user preferences, and variation in device capabilities (which is still limited compared to those of the desktops). These problems underline the need for an adaptation that could tailor adaptive pages to all devices based on user preferences and device types.

We defined adaptive pages that work using *div* structure. We developed and tested a prioritisation engine prototype that adapts and prioritises adaptive pages based on user preferences and device types.

Our results show the practicability and feasibility of the prioritisation of adaptive pages to produce similar web pages on different devices. This approach allows only one version of a website be developed which reduces the costs associated with developing and maintaining multiple versions of sites, and ensures consistency of pages on all devices. It is easy for the developers. Developers can set defaults items to be prioritised and displayed on different devices without changing the original desktop version. The desktop (base adaptive) page can be used on multiple devices without source modification. The prioritisation also allows users to have only items of interest displayed; and with carefully thought out defaults, only a minor customisation is required for the majority of users. The prioritisation also imposes only small overhead.

Our findings demonstrate that prioritising web content on the server side provides a consistent and better user experience across different devices.

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Appendix A
Overview of Mobile Devices Technologies

This appendix contains the material discussed in Section 2.3.

A.1 Types of Mobile Devices

No.	Types of Devices	Screen Size / Resolution	Colour depth	Connection type	Features
1.	**Tablet**	1024,1280x76, 88008,			
	iPad2	1024x768		- Bluetooth, Wi Fi - HSPA 3G/EVDO Rev A	
	Samsung Galaxy Tab 10	1280x800		- Bluetooth, Wi Fi - UMTS, GSM HSPA+	
2.	**PDA**	320,640x320, 480	65K	At least one of these: IrDA, Bluetooth, and/or Wi-Fi	Standard PDA can be a mobile phone, fax sender, Web browser and personal organizer. Use any one of the mobile OS
3.	**Smart phones**	240-800 x 240-480	65K	Any combinations of: Bluetooth Wi-Fi infrared 3G HSDPA	Voice call, text messaging, personal information management, local data transfer between phone and computer, camera.
	e.g. - Palm Centro	320x320		CDMA2000/EVDO Bluetooth 1.2	Palm OS 5.4.9, 1.3 mega pix. Camera, QWERTY keyboard.
	e.g. - iPhone	3.5 inch 480x320		Wi-Fi (802.11 b/g), Bluetooth, GPRS/EDGE	2.0mp Camera, soft QWERTY keyboard, OS X, ARM CPU, multitasking
4.	feature phone	240-800 x 240-480		CDMA2000 1X 1900/800, 3G, GPRS/EDGE; Bluetooth	Phone that can run applications based on JavaME or BREW; less integrated with other features of the phone
	e.g. LG Chocolate touch	400 x 240		CDMA2000 1X	

A.2 Mobile Operating Systems

No.	Operating System	Description
1.	Symbian OS	• By Symbian Foundation • Runs exclusively on ARMS processors on S60 platform, UIQ, MOAP. • Devices used this OS include: Ericsson R380, Nokia E70, Nokia 9210, UIQ interface, Nokia S60, etc. • Supports GPRS, EDGE, Bluetooth, etc.
2.	BlackBerry OS	• By RIM • Runs on ARM-based processors. • Support Bluetooth, mobile Wi Fi
3.	iOS	• By Apple • Runs on ARM • Support Bluetooth, mobile wi fi
4.	Android	• From Open Handset Alliance (Google) • Runs on ARMS, MIPS, x86 • Supports Bluetooth, mobile Wi-Fi, USB
5.	Windows Mobile	• By Microsoft • Runs on ARMs • Support USB, Bluetooth, mobile Wi-Fi
	Windows Phone	• By Microsoft • Runs on ARMs • Support USB, Bluetooth, mobile Wi-Fi
6.	Web OS	• By HP/Palm • Runs on ARM-based processors
7.	Bada	• From Samsung Electronic • Runs on ARM-based processors • Support microUSB, Bluetooth, mobile Wi-Fi

The first four operating systems are the most common OS for both smartphones and PDA. The first four are the top mobile OS for 2011-2012 (IDC, 2010; StatCounterGlobalStats, 2012).

A.3 Mobile Browsers

No.	Mobile Browser	Description
1.	Opera Mobile	• By Opera Software • Support for Macromedia Flash Player 7 (for Pocket PC) • Supported platforms - S60, Windows Mobile, Android platforms • Full rendering engine on device
2.	Opera Mini	• By Opera Software • Opera's Small Screen **Rendering** (SSR) technology to reformat the Web page to fit inside the screen width • Supported platforms - Java phones, Windows Mobile, Android, S60, Blackberry, and iPhone
3.	Nokia Series 60 Web Browser	• support HTML, WML and XHTML - normal and mobile web • include Flash Lite player • runs on Series 60 phones
4.	Safari/Phone	• Runs on OS X • Browser for iPhone and iPod Touch • Support CSS, XHTML • For iPhone, iPad, and iPod Touch
5.	Blackberry	• By Research in Motion (RIM) •
6.	Android	• Integrated browser • Based on open source Webkit
8.	NetFront	• By ACCESS co • Use NetFront layout engine • Runs on several Samsung mobile
9.	Blazer by Palm	• Installed on all Palm Treos and PDAs • Use NetFront layout engine
10.	IE Mobile (Pocket IE) by Microsoft	• Runs on Windows CE (WM 6) • Handles DHTML, frame, scripting, and XML • Supports HTTP1.1, FTP, HTTP proxy; Web service provisioning (WSP) and Wireless Support Layer Security (WTLS); WAP Segmentation and Reassembly (SAR).
11.	Openwave Mobile Browser	• Support HTML 4.01, WCSS 1.1, WML, HTTP and WSP Networking • For Microsoft Smartphones and PocketPCs, Symbian S60 e.g., Nokia E70, Nokia N93
12.	ThunderHawk Mobile Web	• Runs on Java/J2ME, Symbian, or Windows Mobile phone or Pocket PC • Supports HTML, CSS level 1 and 2, AJAX, XHTML Basic, frames.

The first six are the top mobile browsers for 2011-2012 (StatCounterGlobalStats, 2012).

A.4 Mobile Networks and Connections

No.	Network Connections	Standards	Data rate	Descriptions
1.	**GSM**		9.6Kbps	The most widely used digital wireless telephony technology
2.	General Packet Radio Service (**GPRS**)	Standard for wireless communications.	Up to 115Kbps	Suited for WAP, SMS, MMS, Internet
3.	**EDGE**		up to 384 Kbps	Can be used for any packet switched applications like Internet and is based on GSM and use TDMA multiplexing technology.
4.	**3G**	Based on International Telecommunication Union (ITU) standards under IMT-2000	~ 128Kbps – 2Mbps	Works on GSM, TDMA, and CDMA
5.	**Wireless LAN**	IEEE 802.11 (wireless LAN)	Up to 1 or 2 Mbps transmission in the 2.4 GHz band.	Use the Ethernet protocol and CSMA/CA, Compatible with 802.11b, 802.11g
		IEEE 802.11a *(Wi-Fi)*	Up to 54 Mbps in the 5GHz band.	Not interoperable with 802.11b.
		IEEE 802.11b (*802.11 High Rate or Wi-Fi)(Wi-Fi)*	Up to 11 Mbps in the 2.4 GHz band.	Not interoperable with 802.11a, compatible with 802.11
		IEEE 802.11g *(Wi-Fi)*	Up to 54 Mbps in the 2.4 GHz band.	Compatible with 802.11, 802.11b
		IEEE 802.11n	Up to 248 Mbps in the 2.4 GHz – 5GHz band.	
6.	**WirelessMAN or WiMAX**	IEEE 802.16 (WiMAX)	WiMAX in the 10 to 66 GHz range	
		IEEE 802.16a (WiMAX)	Added support for the 2 to 11 GHz range.	
7.	**Bluetooth**		Up to 2Mbps in the 2.45GHz band	Does not support TCP/IP and wireless LAN applications
8.	**Ethernet (wired)**	IEEE 802.3 10Base-2 – 1000Base-T	10Mbps - 1000Mbps	

Appendix B
The Mobile Web Survey

This appendix consists of the set of survey materials used for the Mobile Web Survey (Survey 1) and the data collected as disscussed in Section 3.1.

B.1 Research Information Sheet and Consent Form

Research Information Sheet for Software Requirements Questionnaire
Lincoln University

Division: ESD
Applied Computing Group

You are invited to participate as a subject in a project entitled

'One Web' Guideline: Design issues for creating web pages for different technologies

The aim of this project is:
To find out about usage of mobile websites.

The expected time to complete this questionnaire is 15 minutes.

Your participation in this project will involve completing a questionnaire.

The results of the project may be published, but you may be assured of the complete confidentiality of data gathered in this investigation. Only the researcher and supervisor will have access to the raw data. To ensure anonymity and confidentiality your name will not be used in any results or publication. We will record your name only so that we can withdraw your results from the research if you ask us to.

If you are a student at Lincoln then your participation or non-participation will have no impact upon your academic performance at Lincoln University.

The project is being carried out by:

Name of principal researcher **Nassiriah Shaari (as part of a PhD Thesis at Lincoln University)**

Contact Details **shaarin@lincoln.ac.nz**

She will be pleased to discuss any concerns you have about participation in the project.

A template for projects to determine software requirements has been reviewed and approved by Lincoln University Human Ethics Committee. This particular project has been confirmed by the Head of the Applied Computing Group as meeting that template. If you have any concerns about this project you are invited to contact the Head of Group.

Head of Applied Computing Group **Dr Keith Unsworth**

Contact Details **unsworth@lincoln.ac.nz**

Consent Form for Software Requirements Questionnaire

Name of Project: **'One Web' Guideline: Design issues for creating web pages for different technologies**

I have read and understood the research information sheet for the above-named project. On this basis I agree to participate as a subject in the project, and I consent to publication of the results of the project with the understanding that anonymity will be preserved. I understand also that I may at any time withdraw from the project, including withdrawal of any information I have provided.

I confirm that I am over 16 years or age.

Name: _____

Signed: _____ Date:_____

ID: _____

(This number will be recorded with your data only so we can withdraw it at your request)

B.2 Survey 1 - Questionnaire

Section A – Demographic Information

1. Age

   Under 20 but over 16 ☐ 20 - 40 ☐ Over 40 ☐

2. Gender

   Male ☐ Female ☐

Section B – Mobile Device

Mobile device - personal digital assistant (PDA), smartphones, or mobile phones.

1. How long have you been using mobile devices?

   _____ years

2. What do you use your mobile device for? *(Please tick those that apply)*

   Telephone ☐ Email ☐
   Text/SMS ☐ Internet ☐
   Games ☐ Others _____

3. What make and model of mobile device do you own? (E.g. Nokia N80, Samsung E250)

   _____

4. What is your mobile browser? (default browser, don't know, or others e.g. Opera Mini)

   _____

5. Which network is your mobile device on?

   Telecom ☐ Vodafone ☐

6. What is your mobile connection type? (Not sure, 3G, GPRS, others)

   _____

Section C – Mobile Web

Mobile web is the web as accessed from mobile devices.

1. How long have you been accessing the web from your mobile device?

   _____ years

2. How often do you access the web from your mobile device?

Several times a day	☐	Once a week	☐
Once a day	☐	Less than once a week	☐
Several times a week	☐	Never	☐

3. We would like to know how often you access different **types** of website on your **personal computer (PC)** and on your **mobile device**.
   Please choose/tick the best answer.

   1 Never ..... 2 Less than once a week ..... 3 Several times a week ..... 4 Several times a day

Types of websites	PC				Mobile			
	1	2	3	4	1	2	3	4
Email *(e.g., Gmail, yahoo, or hotmail)*								
News *(e.g. stuff.co.nz, nzherald.co.nz)*								
Weather								
e-commerce *(e.g. buying goods etc from Amazon.com)*								
Sports *(e.g. nba.com)*								
Portal and Search engine *(e.g. Google, Yahoo)*								
Community *(e.g. Facebook, Friendster)*								
Chat *(e.g. Yahoo Messenger, eBuddy)*								
Online Games								
Others: _____								
_____								

4. Please name the website you access most frequently from your mobile.

   _____

Based on your answer in 4, please answer question 5 - 7.

5. For the website in 4, why do you choose to access it from your mobile?

_____

_____

_____

6. Please describe any problems that you had encountered while accessing the site in Q4 on your mobile (e.g. problem with navigation, input). Indicate how seriously each problem affects your use of the site.

_____

_____

_____

_____

7. Please name the website you access most frequently from your PC.

_____

8. Do you access the same website from your mobile?

Yes ☐ No ☐

If you answered Yes to Q8 then, please answer 8a, 8b, and 8c.

8a. Does the website look the same and offer the same content on your mobile?

Yes ☐ No ☐

8b. Which version of website do you access on your mobile?

Mobile ☐ Standard ☐ Not sure ☐

8c. Please comment on how easy to use and pleasing you find the website on your mobile.

_____

_____

If you answered No to Q8 then, please explain why you do not access this site from your mobile.

_____

_____

_____

9. There are several potential difficulties accessing a website from a mobile device.

- Please rank each factor according to its level of seriousness.

  Very serious Not very serious

  1 5

- Please comment on any difficulties that you have had while accessing websites from your mobile devices and name an example of website (or the *url*).

Factors	Rank	Comments	Example of website
Access speed	2	Accessing the site takes time – very slow	stuff.co.nz
Content *(Information on the web page)*			
Help/error message *(Help or error message to prompt/assist user)*			
Graphics / image / multimedia			
Link & Navigation within a page *(Moving around the web page or from link/menu to its target)*			
Web page layout *(Organization and structure of the web page)*			
User Input *(Inputting data e.g., URI, user name)*			
Others: _____			

10. Please give any other comments about mobile websites and list other mobile websites you have had difficulty accessing.

_____

_____

_____

_____

~ Thank you ~

B.3 The Mobile Web Survey Data/Results

This section shows the data from the 17 valid respondents of Survey 1 discussed in Section 3.1.3.

B.3.1 Section A – Demographics

A1. Age group

Age	16-20	>20 - 40	>40	**Total**
No	1	15	1	17

A2. Gender

Gender	Male	Female	**Total**
No	8	9	17

B.3.2 Section B - Mobile Device

B2. Use of mobile

usage	**#**
phone	17
txt/sms	17
games	11
email	12
Internet	13
others	5

B4. Browsers used

browser	**#**
default	6
don't' know	5
Windows Mobile	1
IE	4
Safari	1

B5. Network

NW	**#**
Vodafone	13
Telecom	3
N.A	-

B.3.3 Section C - Mobile Web

C2.Frequency of web on Mobile

usage	**#**
Several times a day	4
Once a day	0
Several times a week	7
Once a week	1
Less than once a week	5
Never	0

C8. Access PC most accessed site (C7) on Mobile

	#
Yes	12
No	5

C8a. The sites offer the same content and look and feel on mobile

	#
Yes	7
No	6

Appendix C
The Social Networking Survey – Survey 2

This appendix consists of the set of survey materials used for the Mobile Web Survey (Survey 2) and the data collected and disscussed in Section 3.2.

C.1 The Social Networking Site Survey – Questionnaire

SURVEY – SOCIAL NETWORKING SITES

Section A – Demographic Information

1. Age

   Under 20 but over 16 ☐ 20 - 40 ☐ Over 40 ☐

2. Gender

   Male ☐ Female ☐

Section B -Social Networking Sites (SNS)

1. Please name the social networking site that you access most from your personal computer (PC) and/or your mobile. (*E.g. Bebo, Facebook, Friendster, MySpace, etc*)

2. How long have you been using SNS?

   Less than 1 year ☐ 1 – 2 year ☐ More than 2 years ☐

3. We would like to know how often you perform different **tasks** on the social networking sites.

   i. Please indicate how often you do each task.

   ii. In the '**Rank**' column, please rank in order the five most important tasks you perform on the site. (*1 - is most important*)

Tasks	Frequency						Rank
	Never	Less than once a week	Once a week	Several times a week	Once a day	Several times a day	
	0	1	2	3	4	5	
A. View new notifications/updates							
B. Update your status							
C. Update/edit your profile							
D. Read messages/comments							
E. Write messages/comments							
F. View photos							
G. Update/upload photos							
H. View videos							
I. Update/upload videos							
J. View friends' page/profile							
K. Search/invite/add friends							
L. View forums, discussions, or groups							
M. Update/reply forums, discussions, or groups							
N. Play music, songs, or playlist							
O. Update/upload music, songs, or playlist							
P. Play games							
P. _____							
Q. _____							
R. _____							
S. _____							

4. Do you access the SNS from your **mobile**?

   Yes ☐ **Please answer Q5 – Q8*

   No ☐ **Please proceed to Q9*

5. Which version of the SNS do you access from your **mobile**?

   Mobile ☐ Standard ☐ Not sure ☐

6. Please list the five (5) most frequent social networking tasks (from Q3) you perform from your **mobile**.

   i. _____

   ii. _____

   iii. _____

   iv. _____

   v. _____

7. Please describe any problems that you have encountered while performing tasks from your **mobile**.

   _____

   _____

   _____

   _____

8. Please list any tasks you find difficult to do from your **mobile**. Explain why there is a problem.

   _____

   _____

   _____

   _____

   _____

9. Please explain why you do not access SNS from you **mobile**.

   _____

   _____

   _____

   _____

~ Thank you! ~

C.2 The Social Networking Site Survey – Analysis

This section shows the data for Survey 2 discussed in Section 3.2.3.

Gender

	Male	Female	no Answer
#	17	10	1

SNS use

SNS	#
Facebook	20
Friendster	8
Bebo	6
Multiply	1
Myspace	1
LinkedIn	1

Year of using SNS

Year	#
< 1 Year	6
1 – 2 year	8
> 2 Years	14

Access SNS from mobile

Year	#
Yes	3
No	23
No answer	2

Problems encountered while accessing SNS from mobile

P	Problems
p25	The quality of the website is not as good with the PC. Font too small, graphics not clear and also the speed of the access.
p26	failure of network connections, lack of speed
p14	1. Difficulties in viewing photos/uploading photos. 2. Difficulties in viewing the whole layout

Why not SNS from mobile

Participant	Reasons
1	It's hard to read and write messages. It's hard to edit/upload/view photos by a small screen device
2	small screen; not for free; format/layout changes & takes a long time to download/upload (just a perception that speed is slow)
27	no internet connection - my cell phone
25	It's costly and the quality which led to the satisfaction is very low. However, it is mobile and portable and can be used at anytime and anywhere.
22	On my current mobile, it only has a wap browser so access to SNS is limited.
24	My mobile is not capable for this function
26	-
8	1) My mobile phone is not designed for viewing internet. 2) Compared to PC, Internet speed for mobile is slow 3) May be the price is one of the reason
10	slow
14	-
12	Limited screen display, even the phones has the features
13	1) Cost - expensive 2) Easier with notebook or desktop computer. 3) Faster with PC
15	My mobile cannot access to internet
16	1) My phone is not capable to do so. 2) Do not really spend much time outside my room 3) Accessing from mobile can be expensive.
17	Feel no need to do so
c1	It is more convenient to access from a computer
c2	It cant
c3	-
c4	Not available on my phone
c5	-
c8	Because it's expensive
28	Do not want to pay for Internet charges.
29	I don't know how to access it from my mobile
30	I'm poor. I don't have access to SNS from mobile.
3	Never thought about doing it that way before.
4	The pages ain't the same (too small, simple etc.)
5	Lack of connectivity; Costly; Mobile has no wireless connection.
6	expensive.

Appendix D

The Social Networking Site (Facebook) User trial

This appendix consists of the set of questionnaire, tasks and data for the Social Networking Site trial disscussed in Section 3.3.

D.1 Questions and Tasks

USER TRIAL – SOCIAL NETWORKING SITES (Facebook)

Section A – Background Information

1. Age
   Under 20 but over 16 ☐ 20 - 40 ☐ Over 40 ☐
2. Gender
   Male ☐ Female ☐
3. How long have you been using Facebook?
   Less than 1 year ☐ 1 – 2 year ☐ More than 2 years ☐

Section B – User Tasks

Please 'think-aloud' while performing the following tasks.

Part A

Read messages/comments

1. Read the latest personal message from Cuba Lagi.
2. Read the latest comment from Cuba Lagi on your wall.

Write messages/comments

1. Write a new message to Cuba Lagi.
2. Write a new comment on Cuba Lagi's wall.
3. Reply to the latest comment from Cuba Lagi on your wall.

View photos

1. Find out how many photos in *Spring08* album.
2. View the photo titled *purple* (tool-tip) from *Spring08* album.
3. Place a comment/tag on the *purple* photo.

Part B

View friend page/profiles

1. Find out which friends are currently online.
2. Find Cuba Lagi's current online status.
3. Find how many mutual friends you have with Cuba Lagi.

View notification/updates

1. View current notifications.
2. View your friends' recent activities/updates for the last 2 days.

Configure homepage

1. Do you configure your Facebook homepage?
   Yes ☐
   No ☐ **Please proceed to Q3*
2. What are the most important changes that you have made?
3. Try making any changes (configure your homepage) from your mobile.

D.2 The Social Networking Site (Facebook) User Trial -Data

This section shows the data for the Facebook user trial discussed in Section 3.3.4.

D.2.1 Demographics

gender

Male	Female
2	4

On Facebook

	< 1 Year	1 – 2 year	> 2 Years
#	2	4	-

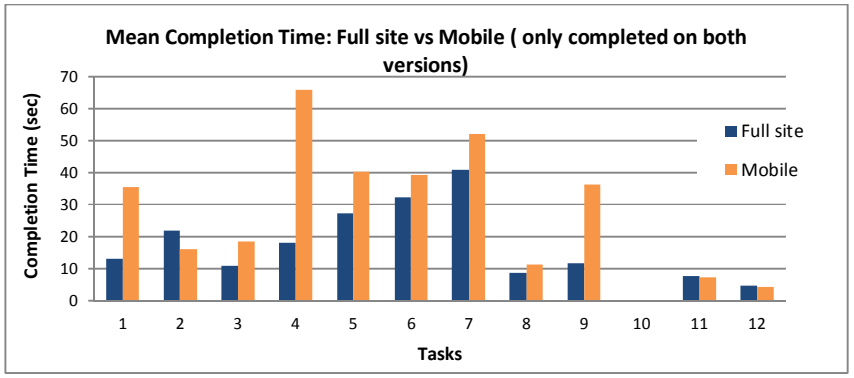
D.2.2 Tasks Completion Time

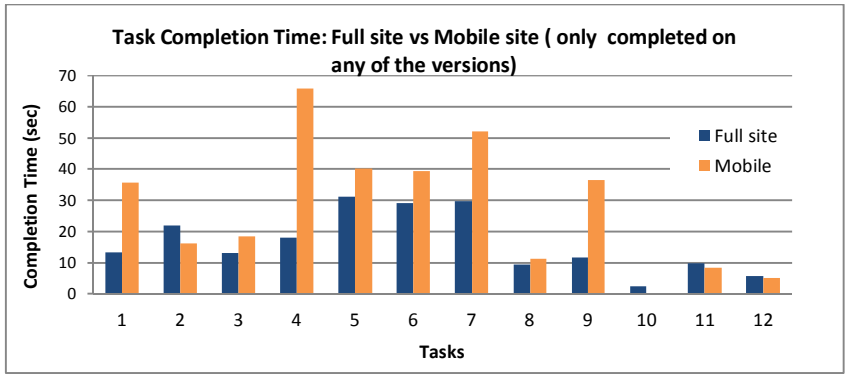
The task completion time (in second) for the each version (the data in bold indicates there were participants with unsuccessfully completed task). Note: **+ incompleted** => include time participants gave up;

- incompleted (=P) => for completion times excluding the time for uncompleted tasks (only the participants who completed tasks on both versions);
- incompleted => completion time for all successfully completed tasks (participants completed the tasks on any of the versions)

Task [successful completion / no of participants attempted]	All attempts + incompleted				- incompleted (=P) (only completed on both versions)				- incompleted (only completed on any versions)			
	Full site		mobile		Full site		mobile		Full site		mobile	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1. Read the latest personal message from Cuba Lagi. [5/5]	13.2	4.66	35.6	21.29	13.2	4.66	35.60	21.29	13.2	4.66	35.6	21.29
2. Read the latest comment from Cuba Lagi on your wall. [5/5]	22	16.45	16.2	6.14	22.00	16.45	16.20	6.14	22	16.45	16.2	6.14
3. Write a new message to Cuba Lagi [2/5]	13	4.12	**83.8**	62.95	11	1.41	**18.5**	2.12	13	4.12	**18.5**	2.12
4. Write a new comment on Cuba Lagi's wall [5/5]	18	9.30	66	22.18	18.00	9.30	66.00	22.18	18	9.30	66	22.18
5. Reply to the latest comment from Cuba Lagi on your wall [4/5]	31.2	13.72	**62.2**	50.42	27.25	12.12	**27.25**	13.30	31.2	13.72	**40.25**	13.30
6. Find out how many photos in *Spring08* album [3/5]	29	17.65	**91.6**	71.96	32.33	19.63	**39.33**	9.29	29	17.65	**39.33**	9.29
7. View the photo titled *purple* from *Spring08* album [3/5]	29.6	36.86	**99.2**	66.40	41.00	47.15	**52.00**	20.95	29.6	36.86	**52.00**	20.95
8. Place a comment/tag on the purple photo [3/5]	9.4	1.52	**74.8**	87.01	8.67	1.53	**11.33**	3.21	9.4	1.52	**11.33**	3.21
9. Find Cuba Lagi's current online status [3/4]	10	4.16	**34.75**	38.08	11.67	3.06	**36.33**	46.48	11.67	3.06	**36.33**	46.48

Task [successful completion / no of participants attempted]	All attempts + incompleted				- incompleted (=P) (only completed on both versions)				- incompleted (only completed on any versions)			
	Full site		mobile		Full site		mobile		Full site		mobile	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
10. Find how many mutual friends you have with Cuba Lagi [0/4]	3	1.41	**90.5**	92.02	0.00	0.00	**0.00**	0.00	2.33	0.58	**0.00**	0.00
11. View current notifications. [4/4]	7.75	11.50	7.25	3.77	7.75	11.50	7.25	3.77	9.67	13.28	8.33	3.79
12. View your friends' recent activities/updates for the last 2 days [4/4]	4.75	2.06	4.25	2.63	4.75	2.06	4.25	2.63	5.67	1.15	5.00	2.65





The graph shows the mean completion time for tasks for only those participants who successfully completed all tasks on both versions of site. Using this approach to analyse the result does not reflect the actual task difficulty. For example, for task 10, all participants were able to complete the task on the full site but none was able to complete it on the mobile site.

The graph shows the mean completion time of successfully completed tasks for those participants who completed each task on any of the versions. For example, for task 10, results indicate there was at least one participant who completed it on the full site, but none on the mobile site. This analysis also does not reflect the difficulties of task. For example, completion time for task 3 looks similar on both version, but three participants gave up on their trial on the mobile site (after attempting it for a long time).

D.2.3 Participants' Comments

Participants' comments on both of the Facebook versions trialled:

	General comments	Full-site (standard) version	Mobile version
p1	▪ posting on wall not to be automatically approved (need 2B approved by user) ▪ most frequent tasks – view friends' profile ▪ search for friends – will display link to friend not straight to friend's page ▪ wall – should only display messages/comments on wall, not notifications	▪ easy to use(mouse) ▪ more features	▪ on mobile just to read/view messages/comments ▪ will get back to PC because easy to use (with mouse) and lots more features ▪ limited [feature and ease of use] ▪ [only for read and view; less features]
p2	▪ Like FB t stay connected with friends and to have photo albums ▪ Can easily chat with friends	▪ Is already good ▪	▪ Too simple version→ Very hard to find the function/links ▪ Want to have the same look and feel of the standard site ▪ Suggestion → to shrink to fit the standard site to mobile screen size ▪ Complicated to use and navigate through
p3		▪ Normal/standard site is ok, am happy – no comments/suggestion ▪ [easier to use]	▪ Very 'bad/stupid' ▪ Don't see the need to use it ▪ Am not desperate to use it, would do it on PC -easier
p4		▪ Ok, used to it ▪ Adequate features	▪ Not user friendly because content/tabs/links being restructured, not organised as on standard ▪ Limited white space, font used ▪ To have organised/structured layout as standard ▪ Not as nice as standard version – structure, font, organization
p5		▪ ok	▪ ok ▪ not all features from standard site need to be there, will cause download ▪ but similar structure, simple navigation - better
p6		▪ Ok, ▪ **Easy** to do/perform tasks ▪ Easy to find the icons/features → **already familiar** ▪ Nice to look at and easier to navigate – wider screen ▪ No problem with standard site	▪ Ok with certain task, e.g. give comments ▪ Can't find mutual friends -> may be mobile site only gives important features – easy to do on standard site ▪ Easier on standard – already/more familiar ▪ Wider screen on standard and faster ▪ Slow on emulator – not really user friendly ▪ Hard to navigate ▪ Can't see profile picture ▪ To have profile pictures & all similar features as on standard site ▪ E.g. link to send message, link to comment

Appendix E
XSLT Stylesheet

This appendix consists of the XSLT stylesheet prepared for by the prioritisation engine disscussed in Section 5.5.

E.1 The XSLT Stylesheet for the Prioritisation Engine

The following figure shows the XSLT stylesheet used for the prioritisation engine.

```
<xsl:stylesheet version='1.0' xmlns:xsl='http://www.w3.org/1999/XSL/Transform'>
    <xsl:output method='html' indent='yes'/>

    <xsl:template match='node()|@*' >
        <xsl:copy>
            <xsl:apply-templates select='node()|@*' />
        </xsl:copy>
    </xsl:template>

    <xsl:template match="body">
        <xsl:copy>
            <xsl:copy-of select="@*"/>
            <xsl:apply-templates >
                <xsl:sort select="@rank" data-type="number"/>
            </xsl:apply-templates>
        </xsl:copy>
    </xsl:template>

    <xsl:template match="div">
        <xsl:copy>
            <xsl:copy-of select="@*"/>
            <xsl:apply-templates >
                <xsl:sort select="@rank" data-type="number" />
            </xsl:apply-templates>
        </xsl:copy>
    </xsl:template>

    <xsl:template match="comment()"/>

    <!-- <xsl:template match="img"> -->
        <!-- rmv tag, plc by alt attr -->
            <!--<xsl:element name="b">[<xsl:value-of select="@alt" />]
            <!--</xsl:element>
    <!--</xsl:template>  -->
</xsl:stylesheet>
```

Appendix F
User Trial Materials

This appendix consists of the set of materials used in the user trials for both Study 1 and Study 2 disscussed in Chapter 6. Both trials used the same set of materials presented here except for the familiarization with the mobile in Apendix F.2, which is only applicable for Study 1 (the Mobile Site Trial).

F.1 Background Questionnaire

Investigating a prioritised website for use with different devices
Pre-test Questionnaire

Part 1 Demographic Information

Please tick the appropriate box for each question.

1. Your age

☐ 16 - 19 ☐ 20 - 40 ☐ Over 40

2. Your gender

☐ Male ☐ Female

Part 2 Mobile Web Experience

3. Have you used touch screen mobile phones?

☐ Yes ☐ No

4. What is your level of confidence in using touch screen mobile phone?

☐ Never used
☐ Not very confident
☐ Undecided
☐ Confident
☐ Very confident

5. What make and model of mobile phone do you use? (E.g Nokia N80)

_____

6. What is your mobile browser? (default browser, don't know, or others e.g. Opera Mini)

_____

7. Do you access the web from your mobile phone?

☐ Yes ☐ No **Please proceed to question 8*

If yes, then please answer questions 7.1 and 7.2

7.1 How long have you been accessing the web from your mobile phone? _____

7.2 How often do you access the web from your mobile phone?
(Please choose one that applies)

☐ Several times a day
☐ Once a day
☐ Several times a week
☐ Once a week
☐ Less than once a week

NEXT ➡

ID: _____

Part 3 Facebook Experience

8. How long have you been using Facebook? _____

9. How often do you access Facebook on the following devices?

Devices	Frequency					
	Never	Less than once a week	Once a week	Several times a week	Once a day	Several times a day
	0	1	2	3	4	5
9.1 Your computer (desktop/laptop)	☐	☐	☐	☐	☐	☐
9.2 Your mobile phone	☐	☐	☐	☐	☐	☐

If you **DO** access Facebook from your mobile, please answer question 9.3 - 9.5, otherwise proceed to question 9.6.

9.3 How long have you been accessing Facebook on your mobile phone?

_____

9.4 Why do you choose to access it from your mobile phone?

_____
_____
_____
_____
_____

9.5 Which version of Facebook do you access on your mobile phone?

☐ Mobile ☐ Standard ☐ Mobile application ☐ Not sure

Please proceed to question 10.

9.6 If you **DO NOT** access Facebook from your mobile phone, please explain why.

_____
_____
_____
_____
_____

NEXT ➡

F.2 Familiarization with the Mobile Sheet

ID: _____

10. Assuming you have the appropriate technology, please indicate how important you think the following tasks are to access on each device.

Very important 1 | Useful 2 | Not important 3

Tasks	On my computer			On my mobile		
	1	2	3	1	2	3
A. View new notifications/updates	☐	☐	☐	☐	☐	☐
B. Update your status	☐	☐	☐	☐	☐	☐
C. Read comments on your status	☐	☐	☐	☐	☐	☐
D. Update/edit your profile	☐	☐	☐	☐	☐	☐
E. Read messages	☐	☐	☐	☐	☐	☐
F. Write/reply messages	☐	☐	☐	☐	☐	☐
G. Update/upload photos	☐	☐	☐	☐	☐	☐
H. View friends' photos	☐	☐	☐	☐	☐	☐
I. Comment on friends' photos	☐	☐	☐	☐	☐	☐
J. View videos	☐	☐	☐	☐	☐	☐
K. Update/upload videos	☐	☐	☐	☐	☐	☐
L. View friends' page/profile	☐	☐	☐	☐	☐	☐
M. Search/invite/add friends	☐	☐	☐	☐	☐	☐
N. View forums, discussions, or groups	☐	☐	☐	☐	☐	☐
O. Update/reply forums, discussions, or groups	☐	☐	☐	☐	☐	☐
P. Play games	☐	☐	☐	☐	☐	☐
Q. Play music, songs, or playlist	☐	☐	☐	☐	☐	☐
R. Update/upload music, songs, or playlist	☐	☐	☐	☐	☐	☐
S. Write comments	☐	☐	☐	☐	☐	☐
T. View posts on your wall	☐	☐	☐	☐	☐	☐
U. _____	☐	☐	☐	☐	☐	☐
V. _____	☐	☐	☐	☐	☐	☐

11. From the tasks above, please **rank the five tasks you think are the most important** to do on each device. Please write the letter corresponding to each task.

Rank	Five most important tasks	
	Computer (desktop/laptop)	Mobile phone
(most important) **1**		
2		
3		
4		
5		

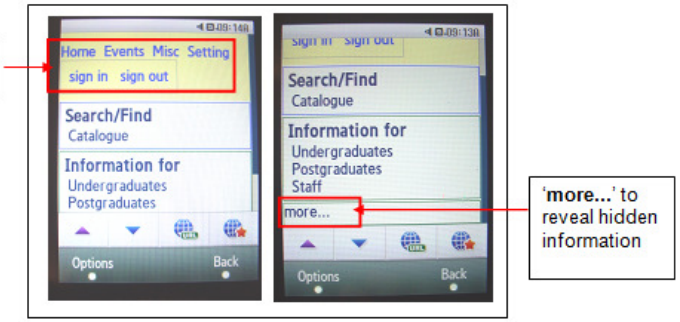
Thank you! ☺

Investigating a prioritised website for use with different devices

Mobile phone and web browsing familiarization

We will start the trial with a session in which you can familiarize yourself with the mobile phone and web browsing. We will use a Samsung F480 for this trial.

You may ask the researcher for help with understanding how to use the phone and the browser.



Page example

Please make yourself comfortable with the phone, try to navigate through the site:

- Click on any links
- Click on the '**more...**' link to see the hidden information.
- Try to post something on the **Events** page

When you feel comfortable with the phone and web browsing, please let the researcher know.

F.3 Trial Instruction and User Tasks

Instructions to participants

In this user trial, you will be logged into Facebook as **Cik Cuba**. You will be asked to perform three tasks on two versions of Facebook:

- Mobile version
- Prioritised version

You are encouraged to "think aloud" while performing the tasks. Aspects that would be useful for you to comment on include:

- How you are performing the tasks (e.g which link you will click)
- Ease of finding information
- Ease of navigation in the page
- Any confusion that you may have

Please do not limit yourself to these.

I will also ask you a few questions about each task as you progress through them.

When you feel you have completed each task, please say so.

Investigating a prioritised website for use with different devices
User Tasks

Task #1

Cik Cuba has been busy with other projects, which have kept her away from Facebook for a few days. She wants her friends to know this. Demonstrate and explain how she would update her status.

NEXT to TASK #2 

Investigating a prioritised website for use with different devices
User Tasks

Task #2

Cik Cuba wants to add **Amy** as a new Facebook friend, but she doesn't know her email address. Demonstrate and explain how she would find **Amy**.

NEXT to TASK #3 

Investigating a prioritised website for use with different devices
User Tasks

Task #3

Cik Cuba wants to show her friends her photos. Demonstrate and explain how she would navigate to the page that shows her photo albums (Cik Cuba's album).

F.4 Questions

The following figure shows the questions asked after participants trialled each version for both Studies discussed in Section 6.3.3.

Version: **Prioritised site** Trial ID:

Investigating a prioritised website for use with different devices
Post-test Questions

Based on your experience in using the site, please answer the following questions.

1. What are the things about the site that you liked?

2. What are the things about the site that you did not like?

3. Was any task difficult to complete? If so, please specify and explain.

4. Please provide any other comments about this site.

Thank you! ☺

F.5 Post Test Questions

The following questions were asked after participants completed the trial on both versions for each study discussed in Section 6.3.4.

Trial ID:

Investigating a prioritised website for use with different devices
Post-test Questions

Thank you for performing the user tasks. Based on your experience with the two versions of Facebook, please answer the following questions.

1. Which version of the site do you prefer?

2. What are the factors that influenced your choice?

3. If you could determine which items are displayed in the prioritised web, how many items would you like to display on your mobile?

Thank you for taking part in this trial. Your consideration and time is appreciated. ☺

F.6 Interview Questions

The Following were the open-ended semi structured interview questions asked after participants have completed the trial and post-test questions.

1. Do you like the idea of hiding certain links/items that are rarely used (or unimportant)?
2. Did you like the more option to reveal hidden links/items?
3. Would you like to be able to determine the order in which items are displayed?
4. Do you prefer the system to personalise the page for you or would you prefer to customise it yourself?
5. Could you please summarise verbally what you thought about the two versions of the sites

Appendix G
User Trial - Results

This appendix provides the data for the User Trial results discussed in Chapter 7.

G.1 Study 1 – Trial on the Mobile

G.1.1 Path, Number of Clicks, and Number of Scroll Taken to Complete Tasks

This section illustrates the path, time (in second), number of clicks, and number of scroll taken by each participant to complete each task. Participants in group A (i.e.1A, 3A, 5A, 7A, 10A, 11A) trialled the Facebook mobile version first; the other participants trialled the Prioritised version first.

For the following three tables, → indicates click; ↓↑ indicates scrolling down and up respectively.

Task 1 – Update Status

Task 1 – Update Status (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Prioritised Mobile (PM)**		**FB mobile (FB)**	
	Path	T C S	T C S	Path
1 A	Home →what's on your mind	16 1 0	170 3 2	Home → Edit → Home ↓↑ →status box
2	Home →what's on your mind	15 1 0	74 3 3	Home ↓↑ →Home ↓ → what's' on your mind
3 A	Home →what's on your mind – [Profile 2 check]	10 1 0	107 1 3	Home ↓↑↓ → status box
4	Home →what's on your mind	8 1 0	69 3 1	Home →Edit Profile	↓→ wall @bottom → status box
5A	Home →what's on your mind	5 1 0	3 1 2	Home ↓↑ what's on your mind
7A	Home →what's on your mind	5 1 0	177 3 3	Home → *Edit Profile* ↓↑ →Home ↓ →status box
8	Home →what's on your mind	7 1 0	269 6 4	Home → Edit Profile ↓ → Profile ↓ → *Inbox* → composed message →Home ↓↑ →status box
9	Home →Profile ↓↑ → info ↓↑ → more... →Account → Profile ↓↑→ info → wall →	350 8 6	87 1 2	Home ↓↑ →status box [status: this is easy]

Task 1 – Update Status (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Prioritised Mobile (PM)**		**FB mobile (FB)**	
	Path	T C S	T C S	Path
	status box [although knows what to do, forgot where he normally update status]			
10 A	Home →what's on your mind	5 1 0	7 1 2	Home ↓↑ status box
11 A	Home →what's on your mind	3 1 0	342 7 6	Home → Edit Profile I→ wall→ info → wall ↓↑ *"I don't know* →Profile → Home ↓↑ → status box
12	Home →what's on your mind "ok"	6 1 0	133 4 6	Home ↓↑ →Edit Profile ↓↑ → wall ↓↑ → Home ↓ → status box
13	Home →what's on your mind	6 1 0	193 5 6	Home ↓↑ →Edit Profile I→ wall → info ↓↑ → Home ↓↑ → status box [looked confused]
14	Home ↓ →more... → what's on your mind	37 2 1	28 1 1	Home ↓ →status box

Task 2 – Find Amy

Task 2 – Find Amy (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Prioritised Mobile (PM)**		**FB mobile (FB)**	
	Path	T C S	T C S	Path
1 A	Home → Find Friends ↓ → search friend's box	78 2 1	67 3 2	Home ↓→ Friends @ d bottom → Find Friends @ d top menu → ↓search @ d bottom
2	Home →search box @ d top	34 1 0	89 3 3	Home ↓ →Find Friends ↓→classmate and co-worker ↓ →search box @ d bottom
3 A	Home I →search box @ d top	32 1 0	113 3 0	Home → Find Friends → search @ d top I →search box @ d bottom
4	Home ↓→ Friends @ leftnav I →search box at d top	60 2 1	33 1 1	Profile ↓ → search box
5A	Home → Find Friends → search box @ the top	37 2 0	237 4 2	Home ↓ →Find friends button (find classmate and co-workers) ↓ → Home → search @ d top I→ search @ d bottom
7A	Home I → search @ d top	23 1 0	76 3 2	Home → Find *Friends* ↓ → Find Friends ↓ →search box @ d bottom

Task 2 – Find Amy (T = time (second); C= Number of clicks; S = Number of Scroll)					
P	**Prioritised Mobile (PM)**			**FB mobile (FB)**	
	Path	T C S	T C S	Path	
8	Home → Find Friends → search box @ the top	74 2 0	262 6 2	Home → Find Friends → Invite your Friends → Friends →Find Friends↓ →Find Friends ↓ → search @ d bottom	
9	Profile I → search box @the top	48 1 0	71 2 1	Home → Find Friends ↓→ → search box @ the bottom	
10 A	Home I search box @ top	34 1 0	88 3 4	Home ↓↑ → Find Friends ↓↑→ search @ d top → search box @ d bottom	
11 A	Home →Find Friends I → search box @ the top	25 2 0	118 4 4	Home → Edit Profile ↓↑ → Home @ d top ↓ →Find Friends ↓ →search box @ the bottom of the page	
12	Home I →search box @ d top	20 1 0	66 3 4	Home → Find Friends ↓↑ →invite your friends ↓↑ → search @ d bottom	
13	Home → Find Friends I →search box @ the top	39 2 0	23 2 0	Home I → search @ d top → search @ d bottom	
14	Home → Find Friends ↓ → Find friends (under email) -- Friends suggestion → Friends (left navigation menu) ↓ → search for people	188 4 2	418 15 12	Home → Find Friends ↓↑ →invite your friends ↓ →cancel → people you may know → Find Friends @bottom of page → Find Friends @ d top →invite your friends ↓↑ → Amy in add box → find more friends ↓↑ → People u may know ↓ → see more ↓↑ → Search @ the top [overlooked the search box] →find people you email ↓↑ → people you may know → search @ the bottom	

Task3 – Show Album

Task3 – Show Album (T = time (second); C= Number of clicks; S = Number of Scroll)					
P	**Prioritised Mobile (PM)**			**FB mobile (FB)**	
	Path	T C S	T C S	Path	
1 A	Home → Profile → Home ↓ "more..." ↓ Photos → recent albums X-unsuccessful	172 3 2	180 3 3	Home ↓↑→ Edit Profile I→view photos of me → wall ↓ → Photo albums	
2	Home → Profile ↓ → "more..." → Photos tab	44 3 1	47 2 2	Home ↓ → Profile ↓ →Photos	
3 A	Home → Profile → more... → Photo	62 3 0	235x 2 6	Home ↓ cik cuba ↓ → View photos of me →Home ↓↑ Profile ↓↑ X-gave up	
4	Home → Profile↓ → 'more...'	56	192x	Home ↓ →Upload photos → Home ↓	

Task3 – Show Album (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Prioritised Mobile (PM)**		**FB mobile (FB)**	
	Path	T C S	T C S	Path
	→ Photo tab	3 1	5 2	→ →Profile →view Photos of me *X-gave up*
5A	Home → Profile ↓ →'more...' → photo tab	50 3 1	67 2 1	Home → Edit Profile ↓→ Photos
7A	Home → Profile → wall →'more...' →Photo tab	38 4 0	128 4 3	Home ↓→ Photos (under bookmark) → Edit Profile ↓→ "Cik Cuba" → Edit Profile ↓ Photo albums
8	Home → Profile → wall → info ↓→ 'more...' ↓ → albums	71 5 2	129 6 4	Home ↓ →Photo →Photo stories ↓↑ *Profile"* → Edit Profile @ d top → view photos of me → Edit Profile ↓ → Photo albums
9	Home ↓↑→Profile → wall →Account ↓↑ →Home ↓ →more... ↓↑ →Photo ↓ → Recent albums ↓↑ ǀ →My Uploads	376 8 10	301 7 6	Home ↓→ Photos ↓↑ →Upload → Most Recent →Photos ↓↑ →Photo Stories →Photos →Cik Cuba ↓ Photos albums
10 A	Home → Profile ↓ →more... →Photo	29 3 1	78 3 4	Home ↓→ Photos ↓↑ →Profile ↓→Photo albums
11 A	Home →Profile ↓→ more... →Photo tab	48 3 1	85 4 1	Home →Edit Profile → View photo of me →Edit Profile ↓ → Photo Albums
12	Home →Profile ↓→ more... →Photo tab	44 3 1	246 11 2	Home ↓ → Photo ↓ →most recent (photo stories) →Photo →Upload photo →Home →more (bookmark) → Photo →Edit Profile → view photo of me →Edit Profile →Photo Albums
13	Home → Profile → Account ↓↑ → Home ↓↑→ more... →Photos → Photos ↓↑ →My Uploads	370 7 6	449x 13 4	Home ↓ →Photos → Home →Edit Profile →Home ↓ →more →Photo (bookmark) →Most Recent →Photo →search →Home ↓ →Photo ↓ →most Recent → Photos X-gave up
14	Home →Profile ↓ → more... →Photo tab	57 3 1	565x 14 6	Home ↓ →Photo (bookmark) →Photo stories ↓↑ →top news →status → Photos stories @ the bottom of the page →Upload Photos →Back Photos stories →Top News →Photos ↓↑ →photo stories → Home ↓ → more [bookmark] →Back [to Photos] → status X-gave up

G.1.2 Things Liked

Group	Partici-pants	**Question 1.** What are the things about the site that you liked?	
		Mobile	**Prioritised**
A (FB - P)	P1	"Easy to see if you have new comment"	"It display the figures I'm related with when I'm in the computer. [faces of friends] [icons and menus/links as in desktop]"
	P3	" the colours, the simplicity, less congested"	"I find it easier to navigate"
	P5	"It's friendly enough and simple - easier to use/browse - simple -> not complicated – not many links - menu is not intuitive"	"Much more simple than the previous one And user friendly as well. → menu guide you, more intuitive"
	P7	"All the info are there"	"Easier to navigate 'coz of the lay-out -> less info on the screen."
	P10	"- not too much links provided (simple) - easy to search friends - we can edit profile easily (it provides a direct link to edit profile)"	"- Simple - it provides 3 important links (for me) 1. update status 2. search friends 3. photo albums - there is a news feed"
	P11	"It's easy to access, the instructions is clear, user friendly, easily spotted, the menu is there,"	"Much more user friendly. I can find the menu/link easily, no need to scroll up & down looking for the menu."
B (P-FB)	P2	"I found friends status in the screen and their pictures" << other friends updates and their profile pictures>>	"- Ease to browse by touch screen - ease to search friend's information (photos, comments, etc) - you have the opportunity to update what's in your mind and comment in your friends' status (share information)"
	P4	- None	"It's user friendly (The links are clearly identified) - navigation links are there and clearly stated - similar to PC version"
	P8	"this one is much more Legible, detail info (edit profile)"	"Easy, legible, similar to desktop"
	P9	"Big text box of task1 is the thing I liked"	"The search function is the thing I liked. It is the most easy to use because it is on the top."
	P12	"None"	"It is easy to use. When I click on the required page it changes colour to red this makes it easy to know what page am I in."
	P13	"Inbox – displaying 10 [messages] per page is very flexible. We can reply instantly & delete; Inviting friends using phone/email is good option." <General opinion about the feature, it was not tested in the trialled.>	"Reading message as well as write comments"

Group	Partici-pants	**Question 1.** What are the things about the site that you liked?	
		Mobile	**Prioritised**
	P14	"The layout is quite clear."	"Can update status easy using mobile. Update status feature appears at the same at the top as what you normally have on the computer"

G.1.3 Things Disliked

Group	Partici-pants	**Question 2.** What are the things about the site that you disliked?	
		Mobile	**Prioritised**
A (FB-P)	P1	"I'm not familiar with the positions of the items of Facebook in the phone, so it was difficult to look for the information that I want."	none
	P3	"The term used for the menu is quite confusing, e.g. Edit Profile/Profile"	"I don't think I have much problem with this site."
	P5	"Less button to navigate - you can't find links to certain items easily"	"Button 'more', so I have to click it to expand the page"
	P7	"- got confused with the layout on the screen because I have to get familiar with the layout on the mobile screen. - lots of scrolling"	"Scrolling"
	P10	"- the fonts are too big -> it seems the screen like full of fonts [text]"	"None"
	P11	Small pictures due to phone size	Small pictures due to phone size
B (P-FB)	P2	"in the top of the screen is the option about how to search friends instead of look your status or friends' status." << other friends updates and their profile pictures>>	"Not all the links are shown in the screen (at least the more important) [hidden links]"
	P4	"It's confusing. Some of the links that are normally there are missing. Not user friendly."	"Space – restricted / inconvenient [because on mobile]"
	P8	"Legible, detail info"	"Easy, legible, similar to desktop"
	P9	"Links are so confused."	"Links on the bottom such as photos… supposed to get the photo at the top or somewhere because people all most using the photo a lot, But, unfortunately, it's at the bottom, very easy to miss"
	P12	"I have to click on too many links to find things that I am looking for. When I want to find Amy, I thought I can find her by clicking on the find friends link but I have to find her from the search button."	"The extra navigation links <left col nav> should be at the top. Messages link should be at the top"

Group	Partici-pants	**Question 2.** What are the things about the site that you disliked?	
		Mobile	**Prioritised**
	P13	"I won't be changing profile picture very often; So, I don't expect it in the beginning of the page. "Friends" & "Inbox" menu is on the bottom, I need to scroll down to access my friends & emails."	"Interaction with the device (mobile) is not good because icons are very small & I'm not familiar using mobile (e.g.:- scrolling, clicking). If there are some 50 messages, it would be tough to keep on scrolling [instead show 10 messages per page"
	P14	"Can't find things that normally I can easily find."	"I find it's bit hard to use than computers"

G.1.4 Difficult Tasks

Group	Partici-pants	**Question 3.** Was any task difficult to complete? If so, please specify and explain	
		Mobile	**Prioritised**
A (FB-P)	P1	"Yes, it was difficult to look for the exact information that I was asked to look for. I'm used to see all the screen and all the information at once."	"Again, with time to get used to it, However it was easier to look for the information due to the figures that help me" < Icons and links that look similar to desktop >.
	P3	#3, "I can't complete task no 3. [I think because I'm looking for the word photo album and I can't find it there, and the only thing that I can find is View photos of me, which I thought that from there may be I can get... From going to view photos of me, I thought from there I can go to cik Cuba's photo albums, but what I have there is only two pictures of Cik Cuba] "	"I find the tasks are ok [because already familiar with the phone]"
	P5	"No.3 because I have to more steps compare to desktop version of Facebook"	"No.3 because I have to click button 'more' to expand the page"
	P7	#1, "The status task because I've had to familiarise with the lay-out"	#3 – "Looking for the photo albums because I have to scroll. need to scroll down to click the "more..." link."
	P10	#3, "show the albums because I am not familiar with the site"	"Easy to complete the task"
	P11	#1, "I found it quite difficult to complete my Task 1 since I'm not familiarized with the mobile FB itself"	"No, it's much easier compared to the 1st version"
B (P-FB)	P2	"Yes, because all links are in different positions - to update my status - look for friends Compared to first version."	"No, but there are many links in different position compared to the computer's screen [to personalize a bit more]" <<to make it easier to locate and use.>>
	P4	#3, "Looking for photo albums" [ya.. ok, because, I'm familiar with the	"phone problem phone problem – not familiar with phone/touchscreen

Group	Partici-pants	**Question 3.** Was any task difficult to complete? If so, please specify and explain	
		Mobile	**Prioritised**
		other one, so it's… you know where to get it.. the photos so then you click the whole photo albums will come out, so you just choose, but this one, you know it's confusing like you know there's photo album but then I'm not sure whether there's a photo album.]"	phone"
	P8	#2, "confusing instruction, scrolling"	"no"
	P9	#3, "Task3 is the most difficult because the photo albums are difficult to be found because I have to visit many links"	- -#3– "Task3. So confused. Scroll down or up to get what I want finally"
	P12	#3, "too many links, (didn't get what expected)"	- #3 "Finding the photo album was confusing. We have to click more to link to the photo page"
	P13	#3 "Not able to see my photographs [finding photo albums] can't find the link to the photo albums"	#3 "Browsing my uploads, because I can't find the link easily, as I'm using mobile which I'm not familiar with the usability."
	P14	"Yes. Task#3. When I click in photo, I expect to see my photo albums, but there are all the comments from friend."	"none"

G.1.5 Preferred Version and Reasons

Group	Partici-pants	Preferred version	Determining Factors
A (FB-P)	P1	Prioritised	" Icons; More information is displayed; Very similar with the version of the computer screen"
	P3	Prioritised	"Because I myself easier to navigate and complete tasks given, getting familiar with the phone."
	P5	Prioritised	" Much more easy to use; Simple; Able to navigate"
	P7	Prioritised	"(compared to the 1st site) lay-out – simple; less scrolling"
	P10	Prioritised	" Easy to navigate; more features; the fonts are not as big as the first"
	P11	Prioritised	"Easy to find/spot the menu/ the order of the items and the layout is user friendly."
B (P-FB)	P2	Prioritised	"Order -> layout of the screen is more friendly"
	P4	Prioritised	"User friendly (links available) - sense of familiarity"
	P8	Mobile	"1) I would prefer the first web on the instruction esp on your mind 2) I prefer 2nd web design. The web design. I would prefer the web design of the second. I prefer second web design because you have your picture and you have your status next to it"
	P9	Prioritised	" Easier to get information – you got what you want in the first site; doesn't take long time; Clearly identify the steps"
	P12	Prioritised	"When I click on the links it will change its colour to red, this will show you what page we are in. - it was easy to navigate to the photo album page.

Group	Partici-pants	Preferred version	Determining Factors
			- it was also easy to find Amy - It is almost similar to desktop version"
	P13	Prioritised	" Different menus for a specific task"
	P14	Prioritised	"I can use my basic knowledge learned from using Facebook on the computer to navigate around in this version"

G.2 Study 2 – Trial on the Laptop

This section shows the data for Study 2, discussed in Section 7.3.

G.2.1 Path, Number of Clicks, and Number of Scroll Taken to Complete Tasks on Study 2

This section illustrates the path, time (in second), number of clicks, and number of scroll taken by each participant to complete each task for Study 2. Participants in group A (2A and 4A), trialled the Facebook full site version first; the other three participants trialled the full mock version first.

Task 1 – Update Status

Task 1 – Update Status (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Full mock version**		**Facebook full site (FB)**	
	Path	T C S	T C S	**Path**
1	**Home → what's on** your mind	5 1 0	6 1 0	**Home → what's on** your mind
2A	**Home → what's on** your mind	6 1 0	6 1 0	**Home → what's on your mind**
3	**Home →what's on** your mind	6 1 0	6 1 0	**Home →what's on** your mind
4A	***Home*** **→ what's on** your mind	5 1 0	5 1 0	**Home → what's on** your mind
5	**Home → Profile →what's on** your mind	13 1 0	23 1 0	**Home →what's on** your mind

Task 2 – Find Amy

Task 2 – Find Amy (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Full mock version**		**Facebook full site (FB)**	
	Path	T C S	T C S	**Path**
1	***Home*** **→ Find Friend ↓ → search**	28 2 1	32 2 1	**Home →Find Friends ↓→ search**
2A	**Home → Find Friends → search** (by name)	14 2 0	22 2 0	**Home → Find Friends → search** @ the top
3	**Home →Parveen →search** @ the top	95 2 0	40 1 0	**Home →search** @ the top
4A	**Home →Friends** @left nav **↓ → Search** for People	42 2 1	21 2 0	**Home →Friends →search**
5	**Home →search box**	9 1 0	9 1 0	**Home → search** box

Task 3 – Show Photo Album

Task 3 – Show Album (T = time (second); C= Number of clicks; S = Number of Scroll)				
P	**Full mock version**		**Facebook full site (FB)**	
	Path	T C S	**Path**	T C S
1	**Home →Photos →MyUpload**	30 2 0	43 4 0	**Home →more →photos → My recent album →my Upload**
2A	**Home → Profile →Photos** tab	7 2 0	10 2 0	***Home*** **→Profile →photo** tab
3	**Home → Cik Cuba**	13 1 0	10 1 1	***Home*** **→Cik Cuba ↓**
4A	**Home →Photos →recent albums →Profile ↓ Photo albums**	45 3 1	18 2 0	**Home →Profile →Photos** tab
5	**Home →Photos → My Uploads**	15 2 0	14 2 0	**Home →Profile →Photos**

G.2.2 Things Liked

Group	Partici-pants	**Question 1.** What are the things about the site that you liked?	
		Full mock version	**Facebook full site (FB)**
A	1a	"User friendly command"; "Have menus and links available"; "able to search and add friends";	"drop down menus and application - easy to search for functions; - Instant updating of status or comments"; - viewing of photos, feature is there"; - searching or adding friends"
	3a	"Info is widely shared and cost free"	"Info is widely shared and cost free
	5a	"Can share photos and status"	"Can share photos and status "Can see news feed of others
B	2a	"More compact could see more on the page"	"Able to chat, view photos, add friends
	4a	"Easy to comment & update status"	"Easy to comment & update status

G.2.3 Things Disliked

Group	Partici-pants	**Question 2.** What are the things about the site that you did not like?	
		Full mock version	**Facebook full site (FB)**
A	1a	Have to 'trial and error' for unfamiliar menus	Frequent notification which could be junk news
	3a	Should filter recommended games	Should filter recommended games
	5a	nothing	nothing
B	2a	Looks more boring and simple	-
	4a	Need many steps to get to function s	Need many steps to get to function s

G.2.4 Preferred Version and Reasons

Group	**Participants**	**Preferred version**	**Determining Factors**
A (P- FB)	1a	Standard	"The drop down menus and applications – easy to search for functions"
	3a	Prioritised	"Because I found 'Amy' faster"
	5a	Standard	"The 1st version didn't show photo on news feed, but the 2nd version show. So I like the 2nd version."
B (FB-P)	2a	Standard	"it looked more creative/interesting" "it display more information" "the layout / news feed displayed other post that I want to see" "it has links to external sites"
	4a	Standard	"For PC I need a lot of information, features and applications..."

G.3 Important Tasks on the Desktop and Mobile

The following table shows users' score for the level of importance for each task on desktop and mobile device.

The ranks are:

- very important (score = 3),
- useful (score = 2), and
- not important (score = 0).

Total score = sum of (score X number of users who select the option)

Tasks	Q10. Important Task	
	Desktop	Mobile
A. View notification/updates	30	19
B. Update your status	21	16
C. Read comments on your status	24	18
D. Update/edit your profile	21	9
E. Read messages	34	25
F. Write/reply messages	31	21
G. Update/upload photos	19	7
H. View friends photos	20	7
I. Comments on friends photos	16	7
J. View videos	18	7
K. Update/upload videos	15	7
L. View friend page/profiles	24	13
M. Search/invite/add friends	24	9
N. View forum/discussion/group	26	13
0. Update/reply forums/discussions/group	23	11
P. Play games	12	9
Q. Play music/songs/playlist	16	17
R. Update/upload music/songs/playlist	13	12
S. Write comments	27	16
T. View posts on your wall	28	20

G.4 Overall Opinion on Prioritising

The following table shows users' overall general opinion on Prioritising discussed in Chapter 7.

Note:

- ✓✓ = liked; ×= disliked; ✓× = liked but preferred not to; ✓= not important; n.a = no answer
- Participants like the '*more...*' link generally because it will reveal the hidden (removed) info; and a few also only like it if they could determine its location.

Group	Participants	Do you like the idea of hiding unimportant information Do you like the more link Would you prefer to specified your preferences Would you like to determine the order of items displayed Customise or personalise (C/P)				
		hide	'more…'	specified	sort	(C/P)
Study1 (A)	P1	✓✓	✓✓	✓✓	n.a	
	P3	✓×	✓✓	✓✓	✓✓	C
	P5	✓✓	✓✓	✓✓	✓✓	C
	P7	✓✓	✓✓	✓✓	✓✓	
	P10	✓✓	✓✓	✓✓	✓✓	
	P11	✓✓	✓✓	✓✓	✓✓	
Study1 (B)	P2	✓✓	✓✓	✓✓	n.a	C
	P4	✓✓	✓✓	✓✓	n.a	
	P8	✓✓	✓✓	✓✓	✓✓	
	P9	✓✓	✓✓	✓✓	✓✓	
	P12	✓✓	✓✓	n.a	✓✓	
	P13	✓✓	✓✓	✓✓	✓✓	
	P14	✓✓	✓✓	✓✓	✓✓	
Study2	P1a	✓✓	✓✓	✓✓	✓	C
	P2a	✓✓	✓✓	✓✓	✓	
	P3a	✓✓	✓✓	✓✓	✓	C
	P4a	✓×	✓✓	✓✓	✓	C
	P5a	✓✓	✓✓	✓✓	✓	C